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OF THE

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TO THE MEMBERS OF THE SECTION ON OPHTHALMOLOGY

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All the completed papers for the program of the Section on Ophthalmology of the American Medical Association, St. Louis Session, 1910, will be found herein, and, in most cases, in the order in which they will be presented for discussion. Provision has been made for notes on the margins of the pages and on the blank page following each paper.

Following the plan in force during the last few years, the papers will not be read before the Section but each author will be allowed not to exceed ten minutes in which to summarize the points in his paper and to introduce discussion. The member appointed to open the discussion of any paper will be allowed not to exceed ten minutes and subsequent speakers five minutes. The official stenographer requests that the manuscripts of all written discussion be turned in to him.

Attention is called to the desire on the part of the officers of the Section to have an exhibition of pathologic specimens, photographs, charts and printed histories of rare and interesting cases. Members are also invited to exhibit new instruments and appliances which may be of interest to the members of the Section. A room adjoining the meeting place has been set aside for exhibitions and demonstrations, and specimens, photographs, instruments, appliances, etc., will be under the protection of a watchman and suitable burglar and fire insurance. Sufficient microscopes will be at hand for the examination of slides. Those desiring to contribute to this feature are requested to correspond with the ophthalmology member of the local Committee on Section Meeting Places, Dr. M. Wiener, 500 Carleton Building, St. Louis, for further particulars.

The officers and executive committee desire to thank the essayists for their cooperation in making it possible to issue the presession volume on time.

ALBERT E. BULSON, JR., Secretary.

W. C. POSEY, Chairman.

THE BOUND TRANSACTIONS

All of the within papers, together with the formal discussion of the same at the St. Louis session, will be printed and bound in cloth, thus constituting the Transactions of the Section of Ophthalmology of the American Medical Association for 1910. Members of the Section and others may obtain these bound Transactions at $1 a volume by sending subscriptions to the American Medical Association, 535 Dearborn Avenue, Chicago, on or before July 1, 1910. After the volume is published the price will be $1.50.

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A STUDY OF TRANSILLUMINATION *

PERCY FRIDENBERG, M.D.
NEW YORK

The data presented in this paper were gained by clinical observation of a large number of normal and diseased eyes in adults, children and infants, transillumination of enucleated globes in the rich and varied collection of the Pathological Laboratory of the New York Eye and Ear Infirmary, and experiments with globular artificial eyes filled with blood, serum, fibrin and various colored fluids. In the last two categories, the possibility of controlling and proving the facts determined during transillumination was of great practical value. The results were such as to corroborate, in the main, what clinical ophthalmology has taught us in regard to the optical reaction of various intra-ocular structures to light transmitted through the sclera; yet a number of instructive and interesting as well as novel exceptions were encountered which will be considered somewhat in detail later.

Both the Sachs and Würdemann lamp were used throughout; the examinations being conducted in a dark room and sometimes exclusion of light was further effected by the use of a black rubber sheet over the head of the examiner and subject. Examined in this way, the normal sclera was always found to be uniformly translucent, something like the web of the fingers when held up to bright light.

In enucleated eyes this trans-scleral glow clearly outlined the entire globe and appeared at the pupil as a bright red reflex. The latter was most intense when the transilluminator was placed at the posterior pole, and the rays came directly forward toward the eye of the observer, or when it was placed over the ciliary body,

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and the pupil inspected obliquely from the opposite side. The latter is, of course, the only way in which bright illumination can be obtained *intra vitam*. The cornea offers, as might be expected, no obstruction whatever to transmitted light. It is somewhat surprising, however, that corneal opacities, no matter where situated or how dense, seem to melt away and give passage to a bright glow. Old leucomata can be transilluminated with ease, allowing us to make out the position and topography of the pupil.

Dense pannus, of recent formation, tends to obscure the reflex slightly. This is probably due to the presence of blood in the newly formed corneal capillaries, as old, obliterated blood-vessels have no such effect. Deposits of uveal pigment on the cornea, as elsewhere in the eye, act as an absolute barrier to light from the transilluminator, so that we have in this instrument a very effective means of differentiating fibrinous or purulent deposits from those containing chromatic granules. The lens, whether clear or opaque to oblique illumination, is absolutely transparent to transillumination, so that not only nuclear, polar, cortical and capsular opacities, but mature senile cataract, as well, seem to have disappeared. In siderosis affecting the lens I have observed some dimming of the light, but this was by no means marked. Cataract, accordingly, offers no obstacle to the detection of an intra-ocular tumor, or possibly of a foreign body, by transillumination.

The true stop or diaphragm for transmitted light is the pigment in the uveal layer of the iris and ciliary body. That in the chorioid is so scattered as not appreciably to affect the rays. The normal iris is absolutely opaque. I have not been able to find any difference between light blue or gray and brown or black eyes, in this respect, nor is there any appreciable difference between the dense ciliary body and the thinner iris. Uveal pigment deposits on the lens, similarly, obstruct the light and appear quite black, no matter how small or thin. In many diseased states of the iris the pigment layer disappears and the light then comes through the stroma of this tissue as brightly as it does through the clear pupil. In many cases of atrophic iris, as in chronic glaucoma, there is a marked reticulation with the appearance of cribriform or accessory pupils.

Secondary membranes after cataract extraction obstruct the light only when they contain dense blood-clot or uveal pigment. In recent intra-ocular hemorrhage there is slight dimming of the light, and a blood-clot entirely arrests it. This was seen most unmistakably in old subretinal hemorrhage and in organized clot in the vitreous. Detached retina is absolutely transparent.

The differentiation of this condition from intra-ocular tumor, particularly from sarcoma, is one of the most important applications of transillumination. As is well known, melanosarcoma casts a dense shadow. This may often be seen as a dark area at the site of the new growth, as well as by dimming of the pupillary glow. It has been claimed that unpigmented sarcoma does not show by transillumination, but at least in one instance I was able to disprove this statement by eliciting a very manifest shadow over a deep-seated leucosarcoma of the chorioid. In the absence of any macroscopically evident pigment—the tumor appeared as a dense white mass—we must assume that the irregular arrangement of tissue cells is sufficient to obstruct the passage of light. Translucent or transparent structures, such as the sclera, cornea and lens, are composed of tissue elements arranged parallel and at right angles to the rays of light which traverse them. An irregular arrangement will naturally obstruct light to some extent even if no pigment be present. Glioma of the retina is always transparent, but the presence of bony or calcareous changes is invariably indicated by opacity.

Transillumination gives no indication whatever of the circumlental space. The annular bright area immediately beyond the limbus depicted in the article by Würdemann is due to light rays which traverse the anterior chamber and come through the thin sclera about Schlemm's canal. It is only seen when the transilluminator is applied obliquely and well forward. When the light comes from the rear, the circumlental space disappears completely in spite of brilliant transpupillary reflex. Again, the appearance and dimensions of this light ring are unaltered by gross changes which not only alter, but completely abolish the circumlental space. Thus, in aphakia, there is no appreciable difference in the light ring from that seen in normal eyes. In buphthalmos and staphyloma of the cornea, the light ring may be seen to depend directly on the dimensions of the anterior transparent segment.

As the lens itself is quite pervious to light rays and, as we have seen, allows the brilliant reflex to pass through it even when completely cataractous, a delimitation of any circumlental space must be an optical, and hence, literally, a physical impossibility. Furthermore, the iris and ciliary body act as an absolutely impassable barrier extending from the pupil to the region of the ora serrata, so that no space within these limits could become visible externally. The comparison of a large number of glaucomatous eyes, before and after operation, with normal globes in patients of corresponding age has failed to reveal any differences whatever in the circumcorneal light ring.

In addition to its well-known uses for the detection of intra-ocular tumors and their differentiation from detachment and optically similar conditions, transillumination gives important information in many cases in which ophthalmoscopy is impossible, and oblique illumination alone teaches us little. This applies particularly to conditions associated with dense opacity of the cornea, such as staphyloma, extensive leucoma and occluded pupil. In dense leucoma with adherent iris, the size and shape of the pupil and the extent of its mobility under a mydriatic can be determined accurately. The site of an optical iridectomy, or the advisability of tattooing a corneal leucoma, may be determined in the light of transillumination.

This method may be combined with ophthalmoscopy for the examination of the ora serrata and neighboring ciliary region at present inaccessible on account of insufficient illumination due to the extreme angle of tilt which it is necessary to give to the ophthalmoscope mirror. With the combined method the structures far forward are seen beantifully.

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MEMORANDA

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THE RADICAL TREATMENT OF LACRIMONASAL DISEASE BY RAPID DILATATION AND ALLIED MEASURES *

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Free drainage of the mucous-membrane-lined cavities and canals of the body is a fundamental essential in preserving their physiologic functions and preventing their infection. The radical relief of tear-duct disease presupposes, therefore, the successful accomplishment and maintenance of a patulous lumen in the lacrimonasal canal. The most important measures utilized for this purpose consist of dilation, incision, introduction of styles, irrigation, electrolysis and cauterization. Extirpation of the lacrimal sac occupies a special field of its own and will not be discussed at this time.

ANATOMIC CONSIDERATIONS

For convenience we may roughly divide the tear-drainage apparatus into three parts, the first portion comprising the lacrimal puncta and canaliculi, the second the lacrimal sac, and the third the *ductus ad nasum*. The bony canal is lined with periosteum covered with cavernous tissue, over which is superimposed a layer of mucous membrane paved with columnar ciliated epithelium. This lining is often thrown up into transverse folds or rugæ which may be annular in arrangement and sometimes possess a valve-like action. The muscle of Horner at the upper end and the valve of Hasner at the lower end complete all the tissue elements essential to our problem.

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The length of the bony canal varies from 20 to 29 mm. and its diameter has been variously estimated at from 2 to 7 mm., the average being 4 mm. Power[1] in 1885 carefully measured 551 bony canals and found that the average diameter was 3.77 in whites, 4.70 in negroes and 4.63 in Mongolians, the general average of all races being 4.22 mm. Theobald[2] in 1877 stated that an examination of 70 bony canals revealed an average diameter of 4-11 mm., while tests of muco-periosteal lined canals in the cadaver showed a caliber of from 4.47 to 5.25 mm. It is evident, therefore, that moist cadavers permitted larger probes to be passed than could be passed through the distorted bony canals of dried skulls. To go a step farther, we may naturally deduce what I have found to be a fact, that the lacrimonasal canal *in vivo* is more distensible than it is in skulls because the bones and tissues are more flexible.

PHYSIOLOGIC DESIDERATA

The normal function of the tear-duct is to draw off from the lacus lacrimalis the excess of tears collected there and to pass them freely downward into the nose. By winking and slight muscular contraction we encourage a suction or siphonic action which carries off this lacrimal fluid through capillary attraction. It should be our aim, therefore, to secure a patulous tear-duct and at the same time to preserve, so far as possible, this physiologic function of capillarity. The ideal method should accomplish this by a sudden wide dilatation of the duct without incision of the punctum or of the canaliculus.

PATHOLOGIC FACTORS

The pathogenic influence of intranasal lesions in the etiology of lacrimal disease is generaly accepted. It is estimated that at least 90 per cent. of these cases have a nasal origin. Secretions that are chemically irritating and laden with infectious bacteria are poured out from the accessory sinuses onto the floor of the nose and carried by reversed capillarity up into the lacrimonasal duct. The inflammation resulting from this irritation may be superficial, causing ulceration, stricture or catarrhal thickening of the mucosa. On the other hand, the infection may penetrate the deeper structures, resulting in periostitis, caries or even in the formation of abscess. We must always bear in mind, therefore, the possibility of two active factors in the etiology of ocular disease, first, the pus-laden nasal fluids which the tear-duct may suck up and transmit directly to the eye, and second, the perverted secretions which the obstructed tear-duct may develop within itself. I have elsewhere[3] referred to this as follows:

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[1] Power, Henry: Lectures on Diseases of the Lacrimal Apparatus, Lancet, London, 1886, ii, p. 908.

[2] Tr. Med. and Chir. Faculty of Maryland, 1877, p. 154.

> If now we concede an infectious cystitis of the antrum, we can comprehend how it is possible for an unlimited stream of pathogenic micro-organisms to be poured out onto the cup-like floor of the nasal chamber, and by capillary attraction drawn up into the lacrimonasal duct, and thence to the ocular cul-de-sac. The lacrimonasal duct itself is, moreover, a most fertile nidus for this bacterial development. The presence of strictures, viscid secretions, ulceration of the lining membrane, or interstitial thickening of the same, all tend to interfere with its siphonic action in the downward drainage of the tears. The bacterial growth is greatly facilitated by the consequent stagnation. Not only are the tears prevented from passing into the nose, but microbic infection is carried upward to the eye by the regurgitation of these septic secretions.

The ocular tissues that are most vulnerable to these septic and irritating fluids are the cornea, the conjunctiva and the palpebrum. Ulcerative keratitis, especially when recurrent, phlyctenular keratitis, vascular keratitis, sloughing of the cornea and wound infection may originate in this manner. Chronic conjunctivitis, eczema of the lid, and blepharitis marginalis may arise from the same cause, while the influence of persistent lacrimal irritation in causing ectropion and entropion is well known.

The absence of epiphora or blennorrhea does not contraindicate lacrimonasal disease. On the contrary, we should always remember these two important facts, first, that we may have obstructive lacrimal disease without epiphora, and second, that we may have ocular infection without visible blennorrhea.

DILATATION OF THE DUCT

While many authorities have advocated probing of the tear-duct, Bowman probably did most to popularize this procedure. His probes, however, were very small, the largest measuring only 1.5 mm. Credit for the use of very large probes is undoubtedly due to Theobald, who in 1877 began to publicly advocate such extreme measures, and to demonstrate the excellent results which he had obtained. His probes were cylindrical in shape with a conical point, the series ranging from 0.25 mm. (No. 1) to 4 mm. (No. 16), the interval of increase being 0.25 mm. Probes of similar caliber were also adopted by Couper of London at about the same time, but were not so well accepted owing to the olivary shape of the point and the larger interval of increase (0.50 mm.).

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[3] Corneal Ulceration due to Nasal Infection, Am. Med., April 9, 1904, p. 599.

While intern in the Wills Eye Hospital, from 1887 to 1889, I saw many patients treated with large probes in the services of Dr. Goodman and Dr. Harlan, and was greatly impressed with the superiority of this method over others in use at that time. My observations, however, convinced me that there were several disadvantages that ought to be overcome: (1) the process of dilatation was too slow; (2) oft-repeated probing created irritability of the tissues; (3) treatment was neglected by the patient because of the frequent visits required; (4) irritating nasal secretions were frequently expelled into the eye by blowing the nose; (5) the capillarity of the duct was completely destroyed by the combined Bowman's incision and the extreme dilatation secured by the use of No. 16 probes (4 mm.). The conviction was forced on me, therefore, that if a large caliber was necessary this should be accomplished at one sitting by a forcible dilatation, *ad maximum,* but without incision of the tissues, thus preserving the capillarity of the duct and avoiding the many disadvantages of the older method.

DESCRIPTION OF AUTHOR'S LACRIMAL DILATOR

I accordingly devised, in 1890, a lacrimal dilator[4] with a cylindrical body and an oval point (Fig 1), based on the old conical dilator of Levis, but essentially different in its size, shape and action. The conical dilator of Levis had three serious defects: first, it was so thin at the point that a false passage might easily be made; second, the cone in entering the bony canal became a sort of wedge that passed through the sac easily but soon became blocked; and, third, the thin point of the instrument did not properly stretch the inferior portion of the canal as it emerged into the nose. I therefore changed the body of the dilator to a cylinder, and made

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[4] Wills Hosp. Rep., January, 1895, i, p. 31.

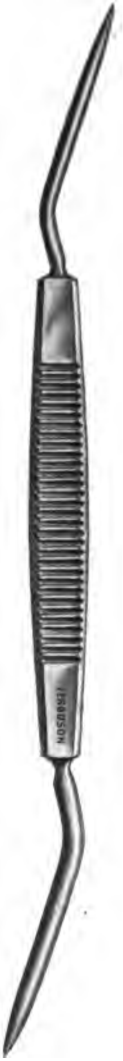

Fig. 1.—Ziegler's lacrimal dilator.

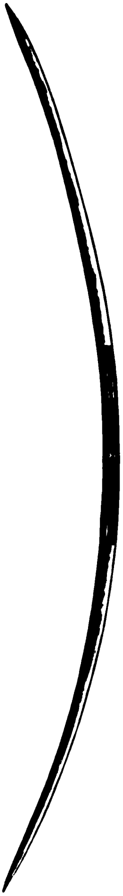

Fig. 2.—Ziegler's needle-probe.

the point more ovoid or bellied, with a sudden widening of the caliber just above the apex. This allows it to dilate so rapidly that the point does not engage, and the body of the dilator never becomes wedged as with the simple cone.

The instrument is made in the shape of a double bayonet, two sizes of the dilator being joined together on a single handle. The smaller end is somewhat sharp-pointed and has a diameter of 2 mm., corresponding to a No. 8 probe, the shaft being 28 mm. long. The larger end is more dull and has a diameter of 3 mm., which corresponds to a No. 12 probe, the shaft measuring 30 mm. in length. The maximum diameter (3 mm.) which I adopted, therefore, was sufficient to accomplish the end desired, although it was considerably less than the 4 mm. caliber exemplified by the No. 16 probe of Theobald. This dilator depends for its success on the rapidity of its dilatation, the avoidance of repetition in probing and the fact that it retains and improves the capillarity of the duct. The instrument is made of forged steel to avoid any danger of bending. A needle-probe (Fig. 2) was also devised for use in cases of atresia. The needle-probe has the same quick expansion just back of the point, which is much sharper than that of the dilator. The oval point in like manner avoids the danger of catching in the tissues. Either the needle-probe or the small end of the dilator may be used to dilate the punctum and canaliculus, but the large dilator should always be used to stretch the *ductus ad nasum.*

AUTHOR'S METHOD OF RAPID DILATATION

Anesthesia.—As the operation is somewhat painful anesthesia is required. The instillation of cocain and epinephrin into the cul-de-sac may prove to be sufficient. These solutions may also be injected into the duct through the small cannula of the lacrimal syringe, or, if preferred, with the hypodermic syringe. As a rule local anesthesia will suffice, but nervous patients will require general anesthesia. In private practice I frequently employ nitrous oxid, but chloroform and ether may also be used for this purpose.

First Stage.—If local anesthesia has been used the patient may be seated and his head covered with a towel. For the right eye the operator stands behind the patient, whose head should rest against the surgeon's chest.

With a small piece of cotton under his left thumb the lower lid is drawn down and out until the margin is tense. Holding the dilator (or needle-probe) vertically in his right hand, the small end is inserted into the punctum with slight force in order to be sure that it is engaged. A feeble click may sometimes be heard, or a sensation of sudden yielding be felt, as the punctum stretches open.

Second Stage.—Still holding the lid tense, the dilator is rotated from the vertical to the horizontal position, and slowly but firmly passed through the canaliculus, the shaft being directed obliquely upward and inward, until the point rests solidly against the bony wall of the sac. If elastic resistance is felt at this point the bony landmark has not yet been reached, and further pressure should be made. As the dilator enters the lacrimal sac a rather pronounced click may be heard, or a yielding sensation may again be felt, as in entering the punctum.

Third Stage.—The small dilator (or needle-probe) is then withdrawn from the canaliculus and the large dilator (No. 12) is inserted, as in the first and second stages, until firm bony resistance is again felt.

Fourth Stage.—The lower lid is now released from the traction of the left thumb. The point of the dilator is held snugly against the bony wall while the shaft is again raised 90 degrees to the vertical position and half rotated on its long axis until the shoulder of the bayonet is turned backward. Still hugging the bone the point of the dilator describes a half-curve backward and downward as it slips over the bony ridge of the lacrimal crest and engages in the sac. It is then pushed with firmness and considerable force, downward and slightly forward, through the nasal duct into the nose. The bayonet shape of the shank allows this to pass without pressing against the eyebrow. The dilator is allowed to remain *in situ* for a moment (or longer if desired) and then withdrawn directly upward.

MINOR ACCIDENTS

A small rupture of the punctum may occur, but this is insignificant and usually heals promptly.

There may be some ecchymosis or even swelling of the lower lid, but this soon disappears.

The nose frequently bleeds for a few minutes owing to a slight scratch of the nasal mucosa by the point of the dilator as it emerges beneath the inferior turbinate.

Patients should be warned not to blow the nose for twenty-four hours, as a very slight rupture in the lining of the canal will permit a palpebral emphysema that might prove alarming and unsightly, although it will disappear spontaneously in a few days.

Irrigation should not be attempted for at least one week, as part of the fluid might escape through some minute laceration of the lining membrane and thus cause infiltration of the tissues.

In a few cases I have noted a crackling sound that indicated slight fracture of the bony walls of the duct, but I can only agree with Theobald in saying that nothing more serious than ecchymosis has followed.

I have often been asked as to the danger of making a false passage. I have never seen such an accident, but an ignorant, careless or unskilful operator may spoil any operation. I have encountered a few cases of caries in which the usual pressure might have caused the dilator to perforate the lacrimal bone and to enter the nose over the middle turbinate. One must always "have an eye in the point of the dilator."

POST-OPERATIVE TREATMENT

The after-treatment is usually very simple, consisting of a soothing eyewash, to which epinephrin may be added in the proportion of 1 to 16. If the eyelids are glued together for a few days following the operation an astringent application will promptly check the conjunctival discharge. If there should be any puffing of the lids ice-pads may be applied. If there is ecchymosis hot stupes are indicated. If emphysema occurs no treatment is necessary, as it will promptly and spontaneously disappear.

INDICATIONS FOR RAPID DILATATION

Rapid dilatation of the lacrimonasal duct is indicated whenever a permeable canal is desired. It is particularly effective in those cases of epiphora and obstruction arising from atresia, localized stricture and general stenosis with interstitial thickening of the mucosa. Absorption of this submucous hyperplasia will often be stimulated by the mere mechanical pressure of the instrument in the canal. The most striking success of rapid dilatation is probably shown in ulcerative lesions of the cornea, and especially those of the recurrent type.

The phlyctenular variety also yields promptly to this treatment. In sloughing keratitis, however, we must supplement the dilatation of the duct by disinfecting the corneal slough with formalin (1 per cent.) and by using an antiseptic wash or spray in the nostril, either hydrogen peroxid or potassium permanganate (1 to 2,000). I do not hesitate to practice rapid dilatation in cases of wound infection (lacrimal) following operation or injury, and even after cataract extraction, thus eliminating the focal origin of the infection. In many of these cases, however, I inject formalin (0.25 per cent.) into the anterior chamber, in addition to disinfecting the margins of the wound and cleansing the nostril. This technic has undoubtedly saved many eyes that appeared to be hopelessly lost.

Rapid dilatation is also of value in cases of chronic conjunctivitis, blepharitis marginalis and eczema of the lid, in which the chemical irritation of the lacrimal fluids is the chief etiologic factor. It is likewise indicated in ectropion and entropion of mild degree arising from persistent lacrimal irritation. Contraction of the socket, with an irritating discharge and more or less palpebral disturbance, is a positive indication for this procedure. I have, for many years, performed rapid dilatation in every case of enucleation, as a routine measure, for the sole purpose of preventing any secondary disturbance that might arise from the accumulation of irritating secretions in the socket. This plan has been markedly successful in preserving a healthy socket.

I have previously discussed the treatment of trachoma[5] before this section (1897) by advocating rapid dilatation of the tear-duct to relieve corneal maceration and pannus through the free drainage of acrid lacrimal secretions. At the same time I recommended that this operation should be combined with canthoplasty or external canthotomy (cautholysis for the purpose of relieving the friction and corneal erosion caused by the tarsal pressure of blepharophimosis. Each one of these procedures thus supplements the other.

ALLIED MEASURES

While rapid dilatation is invaluable in cases of acute dacryocystitis, mucocele, persistent blennorrhea, suppuration, abscess and fistula, certain auxiliary measures may also be necessary. Irrigation, incision, stricturotomy and the insertion of styles or medicated bougies are often indicated to meet the requirements of the symptom-complex which these cases present.

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[5] The Surgery of Trachoma, THE JOURNAL A. M. A., Jan. 15, 1898, p. 131.

Irrigation may be practiced either before or after rapid dilatation. The injection of an astringent or antiseptic solution is always a valuable cleansing adjuvant and often a curative agent. I have devised an all-glass lacrimal syringe (Fig. 3) for this purpose, which is provided with four cannulas; a small gold cannula for introduction into the punctum; a platino-iridium hypodermic needle for local anesthesia; a Tansley cannula with lateral perforations and closed end; and the ordinary Anel or De Wecker cannula.

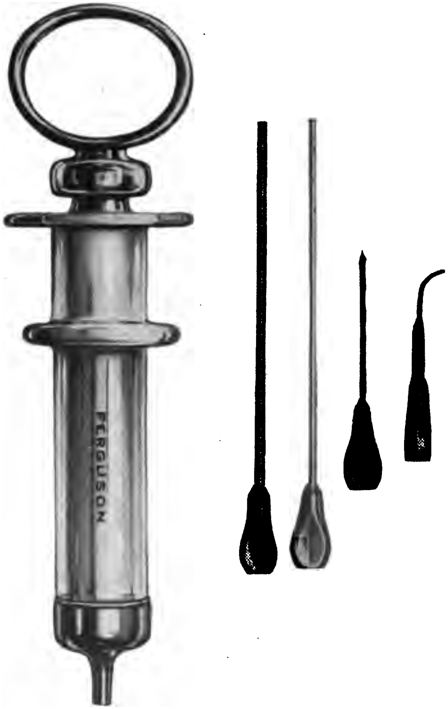

Fig. 3.—Ziegler's glass lacrimal syringe with special cannulas.

Schwenk secures good results by injecting liquid petrolatum into the tear-duct once or twice a week and allowing it to remain until absorbed. Following the method of treating fistulous tracts by the use of bismuth-petrolatum paste, introduced by Beck,[6] of Chicago, I have been injecting his formula modified as follows:

℞.

Formalin	**1/2 part**
Alypin	**1 part**
Antipyrin	**2 parts**
Paraffin	**5 parts**
White wax	**5 parts**
Bismuth subnitrate	**25 parts**
Petrolatum, enough to make	**100 parts**

Mix and make antiseptic paste.

This paste can be heated and injected into the tear-duct with the glass lacrimal syringe, in a fluid state, taking care that it shall not be forced through into the nose, and applying a small ice-bag in order to quickly harden it, *in situ*. If preferred, the compound may be used in a cold or congealed state, and forced directly into the duct by means of the cold paraffin syringe. I usually employ the latter method.

By the substitution of gelatin for petrolatum in the above compound it may be poured into moulds and hardened to form "lacrimal bougies." I have been using these gelatin bougies of formalin-bismuth and also those made with argyrol, but I have not tested them for a sufficient length of time to make a definite report on the results. I am convinced, however, that they will prove valuable. I have observed that the slower they dissolve the greater is their efficiency.

The incision of Bowman is indicated when suppuration is already established. This should be supplemented, however, by rapid dilatation. In performing Bowman's operation I prefer to use an instrument combining my needle-probe on one end and a modification of Weber's knife on the other (Fig. 4). I have shortened this knife, widened the blade, made the edge more oval and used a straighter tip. With such a combination we can stretch the punctum and slit up the canaliculus without changing instruments, which is a great advantage when we have ignorant and unruly patients to deal with.

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[6] Beck, E. G.: Fistulous Tracts, Tuberculous Sinuses and Abscess Cavities; A New Method of Treatment by Bismuth Paste, THE JOURNAL A. M. A., March 14, 1908, p. 868.

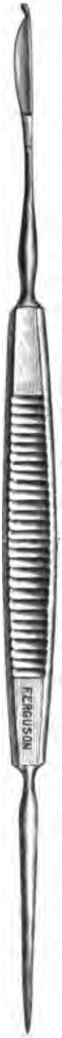

Fig. 4.—Modified Weber's knife with Ziegler's needle-probe.

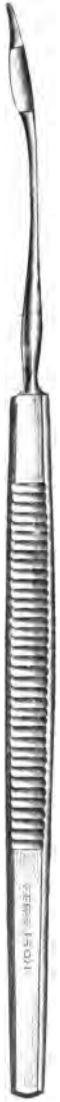

Fig. 5.—Thomas' lacrimal stricturotome.

In cases of lacrimal abscess the abscess should be opened, formalin applied to its lining membrane, Bowman's incision made and rapid dilatation performed. In lacrimal fistula the same method is indicated. A lead style may also be inserted. This promotes free drainage of pus and allows the inflamed tissues to undergo normal healing, without further irritation. If proliferation occurs in the lumen of the duct I employ a lacrimal curette to remove the granulomata. I have devised a small curette (Fig. 6), for this purpose, consisting of a long oval cup with teeth on the edge and a shank that is flexible but not malleable. This can be easily introduced and used with considerable pressure. The procedure is simple and the result will often prove most gratifying.

It is sometimes necessary to go a step further and perform stricturotomy, after the method of Stilling particularly in those cases in which localized bands of contraction are obstructing the canal. Instead of Stilling's knife, however, I prefer the lacrimal stricturotome[7] of Thomas (Fig. 5), which has a stronger blade than the Weber knife, is probe-pointed and has a long malleable shank. Bowman's incision is performed first, followed by rapid dilatation and lastly by stricturotomy. The Thomas knife is inserted into the duct, the probe-pointed blade is pushed down through the stricture and again drawn up, thus cuttting through the stricture fore and aft; or, if necessary, four quarter-sections may be made. An application of formalin to the diseased lining of the duct is sometimes an efficient supplementary measure.

Lead styles have been popular ever since they were first recommended by Green[8] in 1868. They are indicated chiefly in cases of dacryocystitis, stricture of the duct and caries of the lacrimal bones. They may be allowed to remain in the duct until the lining has reformed, although they should be removed at stated intervals and the canal irrigated. Occasionally they will create irritability of the tissues accompanied by granulations and must then be abandoned for some other form of treatment.

As pure lead wire is very soft, and may bend on itself while being introduced, I have modified this by the addition of a small amount of tin alloy, which so

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[7] Tr. Ophth. Sect. A. M. A., 1892, p. 235.
[8] Tr. Am. Ophth. Soc., 1868, p. 31.

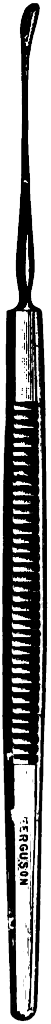

Fig. 6.—Ziegler's lacrimal and chalazion curette.

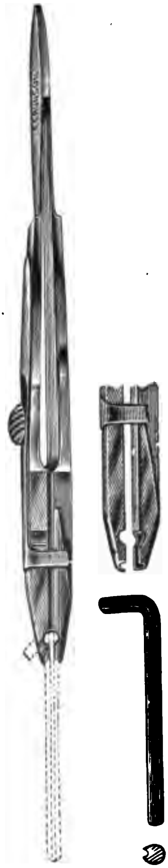

Fig. 7.—Ziegler's lead style introducer with grooved lead style.

strengthens the wire that it can be passed more readily and still retain the necessary flexibility. I have made a further modification of this wire by having it drawn with a small groove, which I think facilitates the drainage problem. I generally use the 2 mm. wire, which is the equivalent of a No. 8 probe. Lead styles have the advantage that they are cut from the solid wire and are preferable, therefore, to any form of gold or silver cannulas, which soon become filled with septic and foul-smelling secretions. They should be made perfectly smooth in order to avoid the deposit of accretions on any roughened area.

To facilitate the insertion of the lead style I have devised a pair of forceps with grooved jaws (Fig. 7) which grasp the style and hold it absolutely rigid. After the style has been introduced into the duct it can be released with the greatest ease by simply pushing the slide catch. If the style should subsequently slip down into the duct, or the tissues should grow over it, there may be considerable difficulty in locating and removing it. By using one of the small curettes, preferably with teeth, it can be gently probed for and easily removed by slipping the curette under the bent arm of the style and drawing it upward.

AUXILIARY TREATMENT OF THE NOSE

We should never lose sight of the nasal etiology of tear-duct disease, and should apply our treatment accordingly. The rhinologist should remove all obstructive lesions, by reducing the hypertrophied tissues and instituting measures to restore ventilation of the upper air chambers and free drainage of the sinuses. As the anterior portion of the inferior turbinate sometimes presses on the valve of Hasner, and thus obstructs the lacrimal drainage, the fleshy fold of the turbinate should be excised, if necessary. Temporary disinfection of the nostril is especially indicated in all cases in which direct ocular infection is suspected.

IN CONCLUSION

Rapid dilatation of the lacrimonasal duct is by no means a panacea, but if used with judgment and discretion will undoubtedly prove a most valuable addition to our treatment of tear-duct disease. Its value lies in the rapidity of the dilatation, the avoidance of repetition in probing, and the retention of the capillarity of the duct. In some cases, however, the capillarity must be sacrificed, and in a very few cases it will be necessary to repeat the dilatation. In cases of periostitis or caries a second dilatation may be necessary, after the lining of the duct has healed. Stretching is likewise repeated in cases in which a prolonged course of nasal treatment has been instituted and completed. These cases of repetition probably constitute 1 per cent. of all cases treated. I abandoned the use of lacrimal probes nearly twenty years ago and have since relied almost exclusively on rapid dilatation of the tear-duct in order to secure the permanent patulous lumen which the radical treatment of lacrimonasal disease demands.

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MEMORANDA

MEMORANDA

THE QUESTION OF ENUCLEATION IN PURULENT PANOPHTHALMITIS

WITH A BRIEF EXPERIMENTAL STUDY OF THE SUBJECT *

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According to Becker,[1] forty-three cases of meningitis after enucleation of the eye had been placed on record up to 1888. The first two of these were reported by von Graefe at the Heidelberg Ophthalmological Congress in 1863, and he took occasion to warn against enucleation when the eye was in the active stage of an acute purulent panophthalmitis. With the exception of the contributions of Andrews[2] and George C. Harlan,[3] little or nothing on the subject has appeared in this country. The contributions of Leber and Deutschmann,[4] in Germany, are well known and are referred to by Andrews in his paper. Within the past twenty years, then, there has been no discussion of this interesting and practical subject, and I think that it is the first time that it has been brought before this Section. Since the above reports, others of a similar character have appeared now and again, as, for instance, that of de Lapersonne,[5] who reported a case in which the meningitis was due to the pneumococcus which was found in the sheath of the optic nerve and also at the base of the brain.

Some years ago a colleague of mine had a distressing experience with one of his patients, a child, who was struck in the eye by a piece of glass. Iridocyclitis followed and later panophthalmitis. The eye was enucleated, and three days later meningeal symptoms

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* This paper has been accepted by the Executive Committee of the Section on Ophthalmology of the American Medical Association, to be presented at the St. Louis Session, June 7-10, 1910. Publication rights reserved by the American Medical Association.

[1] Die Universitäts Augenklinik in Heidelberg, 1888.

[2] New York Med. Jour., Dec. 29, 1888.

[3] Trans. Amer. Ophth. Soc., 1879.

[4] Von Graefe's Arch. f. Ophth., 1885, iv.

[5] Echo méd. du Nord, Lille, 1897.

showed themselves and the child died. The utmost care was employed in the course of the operation and nothing was left undone which might have averted such a result. I recall a number of cases of purulent panophthalmitis in the hospital service of the late J. J. Chisolm. Prompt enucleation was the routine treatment with him for this class of cases, and I have seen some shocking looking eyes removed in the active stage of a purulent panophthalmitis and never with bad result, certainly not with fatal result. I must say, however, that I have no way of determining whether any untoward symptoms developed immediately after enucleation, symptoms which might be explained by a mild meningeal inflammation and which disappeared just as they sometimes do, without sufficiently suggestive to alarm the surgeon or even to attract his attention. It seems to me important that those who make a habit of enucleating eyes in the active stage of a purulent panophthalmitis should keep such patients for several days after operation under the closest observation, with special reference to temperature and symptoms generally suggestive of meningeal involvement. It is quite possible for a mild meningitis to exist for a short time without being detected. It has been my rule to watch the temperature of all patients after enucleation, and I think I can say offhand that no temperature elevation followed. I speak now of eyes in which the inflammation was apparently confined within the eyeball. The conditions are different, however, when we consider an eye which is tense, full of pus, protruding and surrounded by engorged tissues, and generally this has been the picture presented in cases in which death followed the enucleation. It is in the hope of bringing out a full discussion that I bring the subject before this Section. It may be of interest to refer to discussions of this question before other gatherings of ophthalmologists. In 1888[6] the subject was up for discussion before the French society of ophthalmology. While Panas, Dufur, Motais and Gayet favored enucleation in these cases, Meyer, Galezowski and Abadie raised their voices against this procedure. According to Andrews, the late C. R. Agnew expressed himself as opposed to enucleation. In a discussion before the Ophthalmological Society of the United Kingdom,[7] Dr. Brudenell Carter, Mr. McHardy and Mr. Gunn favored enucleation, while Nettleship, Higgins and Mules were opposed to enucleation in such cases. It is evident from all this that there is much difference of opinion among able men on this point.

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[6] La Semaine médicale, May 9, 1888.
[7] Trans. Ophth. Soc., United Kingdom, 1887.

H. D. Noyes, in his text-book, states that from 1868 to 1888 there were 1,164 enucleations at the New York Eye and Ear Infirmary, and, of these, purulent panophthalmitis was present 161 times, and there was no fatal result. It is clear that one can practice enucleation in panophthalmitis a great many times without disaster; but when death has occurred it has nearly always been where the enucleation has been performed in the presence of a purulent panophthalmitis, especially when associated with great phlegmon of the orbital tissues. It would be interesting to get statistics of meningitis in those cases in which the eye had not been subjected to surgical interference. Cases of this character exist, as reported by Webster.[8]

EXPERIMENTAL DATA

The following experiments were undertaken to ascertain whether meningitis could be produced in some of the lower animals by first producing a purulent panophthalmitis and then removing the eye in the active stage of the disease. The animal was always etherized. The only instruments employed in the earlier experiments were a small hypodermic syringe and fixation forceps, which were boiled before using. The following case is an illustration of the behavior of the rabbit after operation, though in this, the first case, the animal died two weeks after enucleation:

Rabbit 1.—The eyeball was pulled forward and downward and the conjunctiva was dissected away, leaving the sclera bare at a point about 2 mm. behind the lens. Five minims of a suspension of *Staphylococcus aureus* were injected into the vitreous. The next day the anterior chamber was cloudy and the eyeball was intensely red. On the third day there was a typical picture of purulent panophthalmitis so the eye was enucleated. The animal declined and died two weeks later but the autopsy showed nothing abnormal in the brain.

Rabbit 2.—Jan. 17, 1909, a rabbit was inoculated in the same way and in three days purulent panophthalmitis was present. The eye was enucleated on the fourth day. The effect of the operation was negative and the animal died five weeks later from an injury received in transferring it from one part of the building to another.

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[8] Trans. Med. Soc. State of New York, 1888.

Rabbit 3.—Feb. 2, 1909, I inoculated the right eye of a rabbit just as in the other two cases. The reaction seen next day was positive but less pronounced than in either of the preceding cases. There was cloudy vitreous with pericorneal redness. The condition subsided in large measure in a week, that is to say, the redness disappeared. Another injection was made in about the same place and this was followed by a sluggish inflammation of the retina and chorioid, leaving a picture which was strongly suggestive of the so-called pseudoglioma Inasmuch as the organism employed seemed to have lost its potency through age; I injected a culture of the same organism of a 48-hours growth. This was followed by an intense panophthalmitis and on the third day the eye was enucleated. The experiment was negative.

Seven rabbits were treated in this manner and with the same result, and with the exception of the two mentioned all were living and well two months after the experiment.

Six guinea-pigs were subjected to the same experiment and the result in every case was negative.

Another series of experiments on rabbits was commenced. Instead of injecting a suspension of organisms an infected foreign body was introduced into the vitreous and allowed to remain there. The foreign body selected was a tack 1/4 inch long. A small incision was made in the usual location with a Graefe knife and the tack was pushed in with a pair of delicate forceps. Three of the tacks had been smeared with a pure culture of *Staphylococcus albus.* On the second day there was always iridocyclitis and on the fourth day typical panophthalmitis. The eye was enucleated at the height of the inflammation. Seven rabbits were treated in this manner and the result was negative in every case.

A new series was commenced and instead of using aseptic precautions the conditions surrounding the usual every-day accident were present. In six rabbits, a small piece of rusty wire 1/8 inch long was introduced into the viterous and in two rabbits a No. 5 shot. In every case purulent panophthalmitis followed and enucleation apparently had no effect on the health of the animal. In nine other rabbits particles of iron, pieces of glass and small fragments of copper wire, just the things which we see produce such disastrous results in human beings, were introduced and the results were negative. Generally speaking, the animal was a little depressed on the second and third day after operation (injection), but this had passed away by the time the enucleation was performed and with the exceptions noted were all alive and well after six weeks when the experiment was regarded as negative.

Thinking that a mild meningitis might be produced by experiments of this character and disappear without causing

noteworthy symptoms six rabbits were killed at periods ranging from three to eight days after enucleation and cover slips from the surface of the brain were examined for pus cells and a piece of the brain was cut in each case from near the chiasm, hardened and examined, but there was no evidence of infection having found its way to the brain.

The results of these (43 in all) experiments tally precisely with what happens in human beings under similar circumstances, and they help to impress us with the fact that death from meningitis induced by enucleating an eye in the acute stage of a purulent panophthalmitis is an exceptional event. That the infection travels by one or more of several routes (i. e., by the lmyph and blood passages, the sheaths of the optic nerve) is probable.

Yet it is my practice to abstain from enucleation, notwithstanding that the evidence speaks for its comparative freedom from risk. I always make two crucial incisions in panophthalmitic eyes, one on the external side of cornea about a quarter of an inch from the limbus and a little below and parallel to the equator of the eyeball, and another incision in a corresponding situation on the opposite side of the cornea. I have had a conviction that to enucleate such an eye was a risk, in spite of what Panas, Mr. Gunn and others say to the contrary, and I strongly hoped to be able to prove this by my experiments. The panophthalmitis which is experimentally produced does not differ apparently in the slightest degree from the process seen in human beings, and, while experiments of this character on rabbits (which are unusually resistant) cannot be regarded by any means as very strong evidence that the procedure is a safe one, it must be conceded that such results coincide with the views held by many ophthalmologists, that the risk, if any, is too slight to be considered.

In conclusion, let me say that, in spite of the experimental and statistical evidence in favor of the comparative harmlessness of enucleating a panophthalmitic eye, I am of the opinion that incisions in the eyeball constitute a measure which is perhaps safer, and I should perform enucleation only as H. Knapp suggests in cases in which a speedy and painless recovery would be of high importance, as, for instance, in old and enfeebled persons.

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MEMORANDA

INTERMITTENT CLOSING OF RETINAL ARTERIES *

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Disturbances of the retinal circulation causing loss of vision are exceedingly complex, and are still imperfectly understood. There are unquestionably some conditions which are not due to embolism or thrombosis. Temporary obscurations are not infrequent clinical manifestations of a disturbed retinal circulation, and they often precede permanent, partial or complete blindness.

These attacks of temporary obscuration were formerly attributed to embolism; the plug supposedly at first obstructed the main trunk of the retinal artery, and later lodged in a branch (Graefe, Mauthner, Schnabel and Sachs). This theory was later abandoned, because of the number of recurring attacks without any evidence of the subsequent fate of the embolus (Loring, Wagenmann).

According to Ole Bull,[1] Zehender was the first to draw attention to vessel cramp as a cause for sudden amblyopia and amaurosis. Benson[2] has reported on a case of intermittent obscurations in which he examined the patient during an attack and found the inferior temporal artery to be bloodless. This condition promptly disappeared, and later the ophthalmoscopic examination gave almost negative results. Dr. Benson thought that spasm probably determined the attacks. Wagenmann[3] examined a patient with recurring obscurations during an attack and found both arteries and veins contracted. Iridectomy checked the process for seven months; then an attack with permanent blindness super-

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[1] Krankh. d. Retinalgefässe, Leipsic, 1903.

[2] Trans. Eighth Internat. Ophth. Cong., Edinburgh, 1894.

[3] Arch. f. Ophth (Graefe), 1897, xliv, 220.

vened. This author believes that the attacks can only be explained by vascular spasm, the local cause being arteriosclerosis. Galezowski has directed attention to the positive existence of vascular spasm of the retinal arteries and its relation to arterial thrombosis. Ole Bull[1] believes that angioneurosis may be as frequent a cause for circulatory disturbances in the retinal vessels as embolism or thrombosis, and that all cases of obscurations are due to cramp, especially as spasm is likely to occur when pathologic vessel changes are present and often leads to a thrombus formation. Osler[4] states that in certain stages of arteriosclerosis arteries are very prone to spasm.

Russell,[5] in a paper on "Intermittent Closing of Cerebral Arteries," suggests the term closing to express this vessel action and describes loss of brain power from intermittent closing of cerebral arteries (temporary paralysis) as it takes part in the production of permanent paralysis. This closing is caused by vessel changes effected by means of the muscular coat; it is partial or complete, producing impairment or complete suspension of function.

As examples of local closing there is the local syncope of Raynaud's disease. Raynaud[6] states that he observed a cramp of the retinal vessels in the sickness which bears his name, but Panas,[7] at Raynaud's request, examined some of his patients and failed to find any difference in the caliber of the vessels during the access of asphyxia. The contraction of retinal vessels in this condition has, however, been found by a number of other observers.

In this group of vasomotor phenomena belong contractions of the retinal artery in epilepsy, malaria, whooping cough and migraine.

As examples of local closing in diseased retinal arteries I wish briefly to report the following cases:

Case 1.—J. B., male, aged 66, was first seen on Aug. 18, 1909, with acute glaucoma in both eyes. The vision in the right eye was 5/200; in the left m. h. Tension was very much increased in both eyes. The man had suffered from prodromal glaucomatous attacks in the right eye for one year and a gradual contraction of the nasal field in the left eye.

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[4] Allbutt's System, Edition 2, vi, 627.
[5] Brit. Med. Jour., Oct. 16, 1909.
[6] Quoted from Dufour, Encyclop. Française d'Ophthal., vi, 117.
[7] Traité des maladies des yeux, i, 619.

Treatment.—He was prepared for operation by eserin, leeches and cathartics. The tension was reduced, and vision in the right eye was 20/70; field normal. In the left it equalled 20/200; the field was contracted to an oval in the temporal half of the field. Iridectomy was performed on both eyes under ether without accident.

Result.—At the first dressing the patient claimed that he could not see with his left eye. The condition remained unchanged though the tension in both eyes was normal and the healing smooth. Ophthalmoscopic examination of the left eye revealed an atrophic disc, no cup, no hemorrhage, but the retinal artery was very narrow, with variations in caliber and white sheaths. Vision was reduced to faintest light preception. The right eye sees 20/30; field is slightly contracted nasally and below. The disc is pale; no cup; distinct endarteritis. The patient showed organic cardiac lesions, general arteriosclerosis and senile paraplegia.

In this case the sight in the left eye was lost after an operation through no fault of the operation or treatment. A plausible explanation seems to me to be that the already narrowed blood vessel in the left eye through some nervous or unknown influence became closed for a sufficient length of time to cause permanent loss of sight. It is another example of the interdependence of glaucoma and arteriosclerosis.

CASE 2.—R. B., aged 53, was first seen on Jan. 29, 1910. Eighteen months ago the vision in the left eye failed suddenly, then improved somewhat, though at present there is only light perception in temporal field. Recently, after severe right hemicrania for four weeks sudden loss of sight occurred in the right eye; after one and one-half hours vision returned.

Examination.—Right eye: pupil was normal; vision 20/100; field normal; retina edematous. The veins were full; the arteries distinctly narrowed. Left eye: disc white; veins tortuous; arteries very narrow. Urine was normal. There were chronic cardiac hypertrophy (valvular lesions), and arteriosclerosis. Blood pressure was $\frac{\text{V. } 265}{\text{H. } 260}$; pulse $\frac{\text{V. } 76}{\text{H. } 64}$; apex beat 5½ inches to left of middle line in fifth space. Sounds at apex were of equal intensity.

Subsequent History.—The patient has been taking nitroglycerin and iodid of potassium. On March 9, 1910, right vision was 20/50; disc normal; veins tortuous, irregular outline; indented; arteries tortuous; often abruptly narrow and nearly invisible; no perivasculitis; one small hemorrhage. Left eye: vision m. h.; disc atrophic; arteries very contracted, often invisible.

Without any periods of obscuration in a patient with general and retinal arteriosclerosis the vision was lost suddenly in the left eye; the condition has remained unchanged. One and one-half years later the vision in the right eye was lost for one hour and a half, and was then regained.

Case 3.—R. L., aged 32, for many years had periods of obscuration occupying either lower or upper half of field, varying in either eye; only one eye at a time was affected. These attacks would last five minutes. The patient suffers often from headache, nausea and vomiting.

Aug. 20, 1909: Present attack began six weeks ago and loss of vision has persisted. Right eye: lower half of field is defective. Superior retinal artery is very thin, with a faint red line; it resembles a wax cast. At a short distance from the disc the caliber of the artery becomes normal.

Nov. 2, 1909: The patient has had several attacks of temporary obscuration in left eye since right eye was affected. There is apparently no cause for these attacks. The upper half of the field is always involved. The inferior retinal artery is full, rounded, hard; no indentation of veins.

In this patient after periods of obscurations the sight in the lower half of the field in one eye was permanently lost, and there have since been some attacks in the upper half of the field in the remaining eye.

Case 4.—C. A. L., aged 60, has general arteriosclerosis, and was first seen on Sept. 21, 1909. Recently there was sudden loss of vision in the right eye, which gradually improved. Now vision is 10/200; retina edematous; marked constriction of arteries; veins full; relative defect in nasal field.

October 27: R. 20/40. Five days later, after mental excitement, there was another attack of blindness principally in right nasal field which passed off.

Jan. 5, 1910: R. 20/30. Inferior temporal artery is distinctly obliterated at one point. Both superior and inferior temporal arteries show caliber variations.

The sight was suddenly lost in one eye and then gradually regained. Subsequently after an emotional outbreak vision was again temporarily obscured in the same eye.

Case 5.—M. S., aged 63, had had no previous obscurations. There was marked general arteriosclerosis.

October 23: After headache and vomiting, was totally blind on awakening. There was no history of having taken any drugs or wood alcohol. Pupils were fully dilated; there was retinal edema. Arteries were small, veins were changed; no pulsation on pressure; no light perception.

October 26: General return of pupillary reaction, light perception in temporal field. Arteries remain very small.

October 30: R. 4/200; L. 2/200; retinal edema; optic discs pale; arteries thin and outlined in white. Gradual deterioration.

December 16: R. 2/200; L. 1/200. Field showed concentric contraction.

January 1: Pupils wide; irresponsive; R. m. h. in temporal field; L. = O.; arteries invisible; optic disc atrophic.

March 1: Patient totally blind; arteries invisible for short distance from disc.

November 1: **R. glaucoma T. +.**

In this case both eyes were simultaneously affected. There was at first some return of vision, which, however, was completely lost after three months. The ophthalmoscope showed at first retinal edema and narrowed arteries; later optic atrophy with obliterated and sclerosed vessels.

Intermittent closing of healthy retinal arteries may occur without any lasting effect on vision. In diseased retinal vessels this phenomenon is of grave significance, as the vessel may remain obstructed or lead to thrombosis. In subjects with retinal arteriosclerosis, especially if obscurations have been present, a rigid general treatment of the arteriosclerosis should be given, mainly with a view of preventing any of the causes which seem to contribute to closing of the arteries.

26 West Fortieth Street.

MEMORANDA

REPORT OF THE COMMITTEE ON COLLECTIVE INVESTIGATION CONCERNING THE OCULAR MUSCLES *

LUCIEN HOWE, M.D.
BUFFALO, N. Y.
HOWARD F. HANSELL, M.D.
AND
THEODORE B. SCHNEIDEMANN, M.D.
PHILADELPHIA

Last year this Committee made only a preliminary report, the substance of which was that considering the clinical importance of the subject, the confusion of our data concerning it, and the necessity of a thorough acquaintance with anatomy and physiology as a basis of clinical work, it was deemed advisable to devote at least a year or two to questions which still remain unsolved concerning the anatomy and physiology of the ocular muscles.

We agreed to call a pair of eyes normal when the vision of each was = 6/6 or better, when the manifest ametropia did not exceed 0.75, and the owners of the eyes never had suffered from any asthenopic symptoms. In asking for studies on the muscles of such eyes, we were careful to avoid theories, to ask only for demonstrations which could be seen or photographed if desired, or for results which could be expressed in figures.

The first step was to arrange these questions into groups, each one having divisions and subdivisions, for different members or groups of members, of the Section. Morever, it seemed desirable, when possible, to have the results verified or corrected by one or two working independently.

It was easy enough to decide on this general plan, the advantages of which were self-evident; but it proved quite a different matter, as was expected, to find proper men ready to engage in what was practically laboratory experiment. At the out-

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set, over eighty members of the Section expressed a willingness to join in the study of the muscles. In the preliminary report last year it was predicted that this number would be much reduced, when careful investigation demanded time and patience of men already engaged in clinical work. That prophecy has been gradually fulfilled.

Although the number now engaged in the inquiry has been reduced to less than twenty, the central Committee is still firm in its conviction of the necessity of first settling certain moot points of anatomy and physiology of the ocular muscles in order to agree, so far as possible, on definitions and methods, before attempting to study any abnormal conditions. Besides reporting thus the number now interested in this subject, reference should be made to the fact that they were selected.

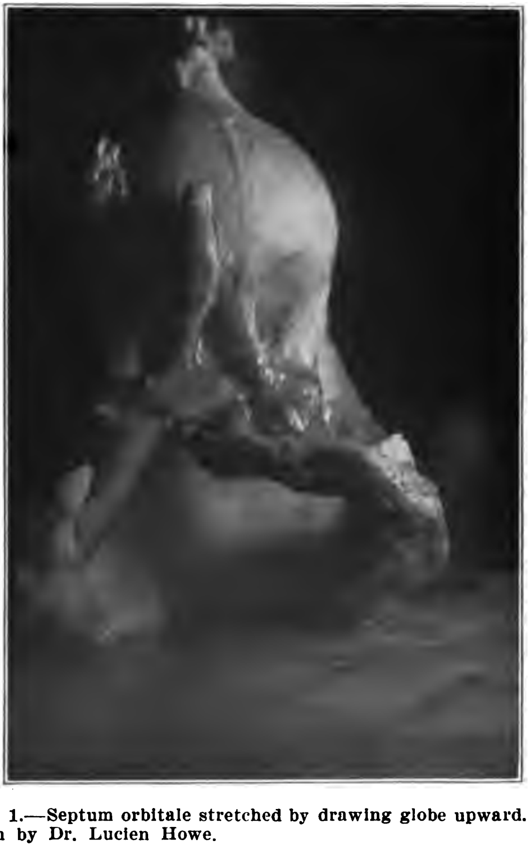

Fig. 1.—Septum orbitale stretched by drawing globe upward. Dissection by Dr. Lucien Howe.

as far as possible, from among the more progressive or from the younger men. There are, however, differences in their apparent qualifications. Some men have been well known as careful observers; although also busy with large private or hospital practice they have so systematized their days as to find leisure for exact investigation. Others are young, or are strangers to our Section. They are all welcome; only it should be understood that the central Committee cannot hold itself responsible for results given by individuals.

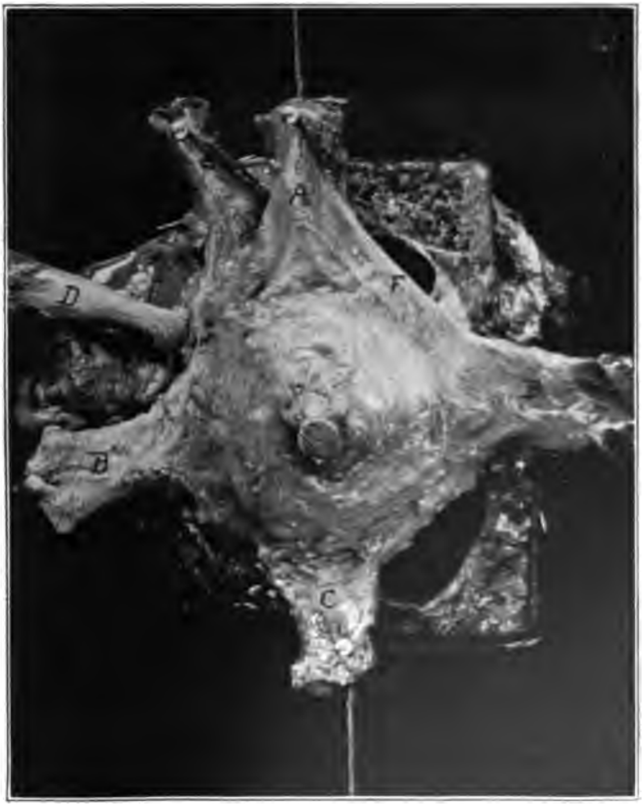

Fig. 2.—Capsule of tenon and ocular muscles; posterior view. A. Superior rectus; B, external rectus; C, inferior rectus; B', internal rectus; D, superior oblique; E, levator palpebrae; F, fold of capsule between A and B. Dissection by Dr. A. C. Durand.

In a report of this kind the Committee can only summarize briefly the findings which have been communicated to them, adding any new evidence which may be available.

In presenting this report it seems advisable to begin with questions of anatomy, and to pass from the simpler to the more complicated problems of the physiology of the muscles.

THE CHECK LIGAMENTS

A subject of much interest to the anatomist and of importance clinically, is the extent and character of the so-called check ligaments.

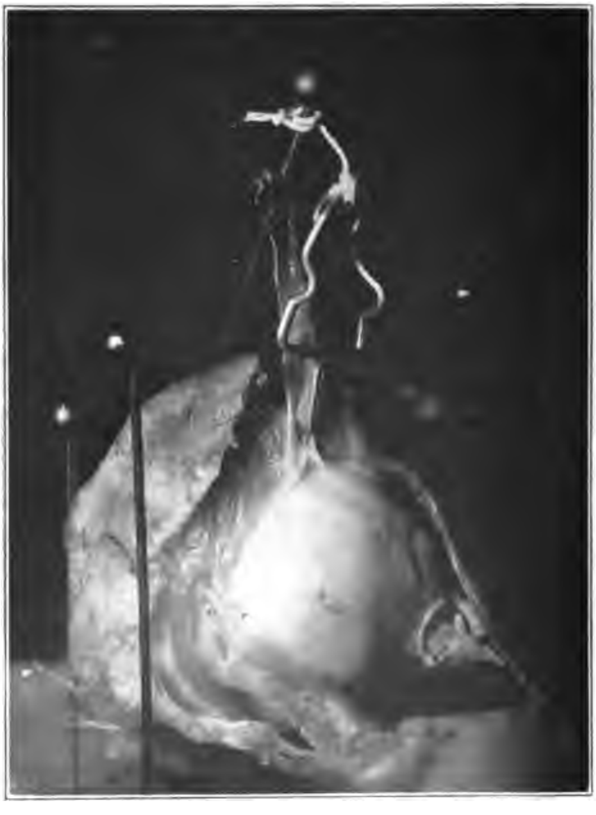

Fig. 3.—Ocular surface of the internal rectus muscle, showing the connective tissue fibers which form the ocular secondary insertion. Dissection by Dr. Lucien Howe.

Even the earlier anatomists saw, from the margins of the orbit, a sort of curtain of connective tissue (the septum orbitale) extending toward the globe. Or as the globe projected partly through this curtain near its center, the connective tissue which passed from the edges of the orbit toward the globe was particularly firm and thick over the insertions of the four recti muscles. These thickened portions, as we know, have been re-described of late years under the name of "the check ligaments" (Fig. 1). The fibers of connective tissue extending over the flat surfaces of the muscles and from their edges have been called "the secondary insertions."

Now, although each of these thickened portions of the connective tissue curtain starts from the orbital edge, it does not always have clearly defined limits when extending toward the outer sheath of the four recti muscles, especially not where it merges gradually into the thinner regions or interspaces of this septum orbitale. The different limits, or the form and function thus assigned by different anatomists to these bands, have confused our ideas and given rise to contradictory theories for operative procedure.

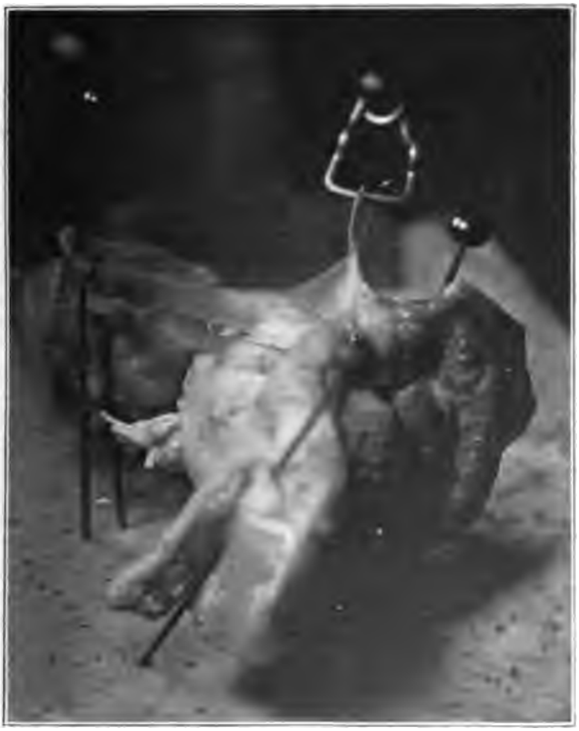

Fig. 4.—The median (nasal) surface of the internal rectus. The connective tissue fibers forming the median secondary insertions of these muscles are here lifted on the forceps. Dissection by Dr. Lucien Howe.

Several dissections made by Dr. A. C. Durand, instructor in anatomy at Cornell University, Ithaca, N. Y., and by Dr. Lucien Howe of Buffalo, together with some photographs of dissections, are submitted to the Section with this report. A detailed description of these preparations might form a short monograph and may be published later.

From these dissections we may conclude:

(*a*) We should limit the term "check ligament" to that thickened portion of the septum orbitale which extends from the orbit to the globe, which is about as wide as the muscle which lies beneath it, and which is limited anteriorly by the conjunctiva and posteriorly by the connective tissue fibers covering the muscle and adjacent orbital tissue.

(*b*) The check ligaments, especially those over the lateral recti, do distinctly check abnormal action of the corresponding muscles. They do not check, however, any of the physiologic motions of the globe.

INSERTION OF RECTI MUSCLES

A second anatomic question concerning which we need corroborative evidence is the nature of the insertion of the recti muscles into the globe.

The earlier anatomists, and many of the text-books, still describe these muscles as attached to the globe by a single ordinary tendon. But more than thirty years ago Merkel and Kallius showed that as these muscles approach the globe their tendons give off fibrous bands at each edge, and also from the orbital and ocular surfaces of the tendon. These supporting fibers at the edges of the muscles, Merkel called the *adminiculum tendinis*, or more recently these connective tissue fibers have been called the "secondary insertions" of the muscles into the globe. The presence and importance of these were shown in an extensive monograph on the subject by Hans Virchow, and in the first volume of a work on the muscles by the chairman of this Committee photographs and more detailed description were given of these secondary insertions. Such evidence left no doubt as to their existence, but as the number of dissections so far made was small, and as the relation of these secondary insertions to operations for tenotomy is evidently so important, it seemed desirable to obtain additional evidence as to the variations which might occur among them. The dissections presented herewith by Drs. Durand and Howe, together with stained sections of the globe and of the muscles, and also the photographs (Figs. 2, 3 and 4) show not only the existence of these secondary insertions, but indicate their evident importance in any operation for tenotomy. Their clinical importance has been tacitly recognized by every one. In making a tenotomy, for example, of the internal rectus, it happens frequently that after the tendon only has been entirely divided, if the eye is cleaned and the patient is asked to look at a distant object, the globe seems to remain in the same position as it was before the operation, being still held by the undivided secondary fibers. But if the surgeon then extends the incision only a few millimeters further, dividing thus the secondary insertions, or even separates them with a hook, a "complete" tenotomy is thus made, and the globe swings outward, perhaps even further than desired. It is evident, therefore, that we should obtain as many data as possible concerning these secondary insertions, not only in the normal condition, but later in connection with the pathologic anatomy of heterotropia.

THE OPHTHALMIC GANGLION

A third anatomic point to which attention has been directed was the ophthalmic ganglion. As the number of afferent and efferent branches are variously described and figured in different anatomies, and as this ganglion undoubtedly bears an important relation to accommodation, it seemed desirable to begin at least to classify our knowledge concerning it. Therefore a series of dissections of this ganglion has been made during the past year by Drs. C. E. G. Shannon and John F. Little of Philadelphia, and also one dissection by Dr. A. C. Durand of Ithaca, N. Y. These specimens are also submitted, and a photograph by the latter (Fig. 5). But it is necessary to

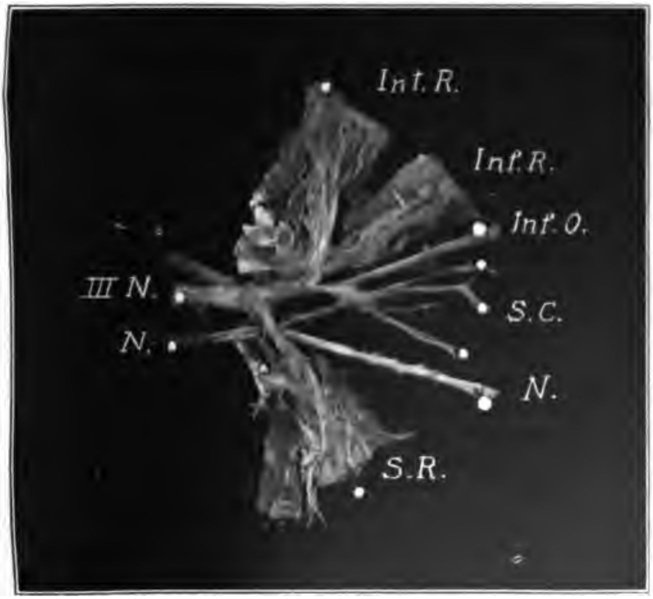

Fig. 5.—View of the ciliary ganglion. External rectus covered with black paper. Dissection by Dr. A. C. Durand.

state that as yet no definite conclusions can be reached concerning the number and arrangement of the branches which go to or from the ganglion. Much less is it possible to make a statement concerning their function.

One or two other studies of the anatomy of the muscles have been commenced, but they are not yet ready for even a preliminary demonstration.

Passing from the anatomy to the physiology of the muscles, it seemed to the central Committee that inasmuch as most functions of the extraocular muscles are dependent on the condition of the intraocular muscles—on what we may call in general the ciliary muscle—it was advisable to study that first.

POWER OF ACCOMMODATION WITH PARALLEL VISUAL AXES

One of the first questions presented related to the power of accommodation with parallel visual axes. Although Donders, Landolt, Hess and others have already described the curves or lines which represent graphically the positive and negative parts of relative accommodation, we have comparatively few data as to the strength of the accommodation when the visual axes are in the primary position. This can be ascertained, of course, by successive trials, until the strongest minus glasses are found which can be overcome, the vision still remaining equal to 6/6.

We have long known, in a general way, that most emmetropes could overcome in this way a pair of—3. diopter glasses. That is to say, we have considered that the latent accommodation with parallel visual axes was equal to about three diopters.

But only during the last few years has any statement been made as to the gradual decrease which takes place in the power of accommodation in normal eyes as age advances.

In order to determine this, Dr. H. W. Cowper, now of Buffalo, N. Y., formerly assistant surgeon in the U. S. Army, made tests of the eyes of twenty-two soldiers of the Twenty-ninth Infantry then stationed at Fort Porter. These men were of rather unusually strong and athletic types. In none did the hypermetropia exceed 0.75, but the ages varied from 21 to 38.[1]

The results in this small number seem to show that from 21 to 25 years of age we can usually count on about 3.5 diopters of accommodation which can be exerted when the visual axes are in the primary position. But this amount of accommodation gradually decreases with the increase in years, as might naturally be expected.

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[1] Acknowledgement should here be made to Capt. W. R. Davis, assistant surgeon U. S A., now at Fort Porter, Buffalo. Capt. Davis rendered valuable assistance to members of the subcommittee, by interesting soldiers to give time to tests of the condition of their refraction, muscle balance, power of accommodation, of torsion, and of other conditions of normal eyes.

This observation on even a few subjects is more far-reaching than might at first appear. Clinicians agree generally that one of the most important and also one of the most difficult questions to be solved in the treatment of ametropia is whether the power of accommodation in a given individual is normal, whether it is excessive (spasm of accommodation), or whether that power is insufficient (paresis of accommodation). It assists us greatly, therefore, to know that in early life—up to 20 or 25—an emmetrope should overcome minus glasses of about 3.50 diopters. This corroborates some statements which have been published within the past few years, and so far as it goes furnishes further physiologic basis for clinical work .

ACTION OF CYCLOPLEGICS

Another fundamental question in connection with the power of accommodation is to what extent we can agree concerning the action of cycloplegics and myotics which are in constant use clinically. This is evidently nothing more than the critical examination of some of the tools with which our work is done. Comparatively few studies have been made of the action of drugs on the ciliary muscles. Perhaps the most recent and complete are those given by Lewin and Guillary in their classic "Die Wirkungen von Arzneimitteln und Giften auf das Auge." In that we have a verification of former observations concerning the action of atropin and homatropin, and several other cycloplegics and myotics.

But still there were desiderata in the form of corroborative observations on moot points. Especially it was desirable to ascertain the different effects, if any, of different doses of the same drug. In doing this, it was evident that the usual method of instilling drops into the conjunctival sac was inexact, for the reason that solutions easily deteriorate, that drops are of unequal size, and the amount which remains on the conjunctiva varies greatly. Therefore for the experiments, our committee sent out previously tested discs, and a description of the method to be followed, with the test types to be used—in other words, the plan adopted was as nearly uniform as possible. In order to make sure that the discs used contained practically the amount of the drug stated by the manufacturers, analyses were first made of all except one lot of the discs distributed. For the care taken in making these analyses, or in having them made, acknowledgment and the thanks of the committee should here be expressed to Dr. H. C. Wood, Jr., of Philadelphia, and Dr. H. L. Begle of Detroit, Mich. It was gratifying to know that the discs manufactured by at least three of the largest firms do contain apparently the percentage of the different drugs as marked on the packages which were purchased by the committee, in open market. It should be added that care was taken not to prejudice the mind of any observer. The name was given of the discs sent, but not of the strength.

The results of these studies of the action of different drugs can be referred to in this report only with the utmost brevity. It should be repeated, however, that each observer is at liberty to publish his own results elsewhere, if desired, and some members will undoubtedly do this. The results are arranged as follows:

Cocain.—Although we use this substance so constantly, and although it is ordinarily regarded simply as a mydriatic, exact measurements seem to show that it also produces a slight but real effect on the accommodation. This is indicated by the experiments made by Drs. F. W. Marlow of Syracuse, N. Y., G. A. Sulzer of Columbus, Ohio, and H. H. Martin of Savannah, Ga. They each used tablets containing 1/25 grain (0.0026 gram). Dr. Marlow found the following results:

(a) In a man of 26, after 10 minutes the accommodation had begun to relax; it reached 3 diopters after 50 minutes, continued so for 70 minutes, and the effects then gradually disappeared. Meanwhile, the pupil had dilated from 3 to 7 millimeters after 20 minutes. The pupil then gradually contracted, and at the end of 110 minutes had almost regained its original size.

(b) In a man of 23 the same amount of cocain produced 1 1/2 diopter of relaxation after 50 minutes. The subject was able to overcome the relaxation only in part when he made special effort, and the cycloplegic effect had disappeared after an hour. Meanwhile the pupil had enlarged from 3.5 to 6 millimeters after 50 minutes, and remained large the rest of the day.

(c) In another man of 24 there was a relaxation of accommodation of 1 1/2 diopters after 60 minutes, with a return to the original condition after 90 minutes. Meanwhile the pupil, after 25 minutes, had dilated from 3 to 7 millimeters, and remained 5.5 millimeters in diameter after 110 minutes.

(d) In a boy of 18, 20 minutes after the application the accommodation had relaxed 2 diopters. It remained at practically that point for about 90 minutes, and then gradually reached the original condition. Meanwhile, after 20 minutes the pupil had dilated from 3 to 6 millimeters, and continued at almost that point after 120 minutes.

Dr. Sulzer found:

(a) In a girl of 17, half an hour after the application the accommodation was relaxed 1 1/2 diopters. That continued for about 30 minutes. At the end of 70 minutes the accommodation had returned to the original condition.

(b) In a woman of 25, at the end of 25 minutes a relaxation of 4 diopters occurred. This gradually decreased, until it had entirely disappeared at the end of 70 minutes. In both cases the changes in the pupil accorded practically with the changes in the accommodation.

Dr. Martin found, in a subject of 18 years, that within 30 minutes the accommodation had relaxed 2 diopters, and continued at that point for 140 minutes. Meanwhile the pupil dilated from 2 to 4 millimeters, and continued that size during that time.

These experiments seem to warrant the space here devoted to them. For they indicate that in spite of the general opinion to the contrary, this drug has a real cycloplegic, as well as its well-known mydriatic action. Of course, this cycloplegic action must be taken into account whenever tests of the refraction are made after its use. Moreover, attention should be called, incidentally, to the important fact that cocain is contraindicated when there is any tendency to increased tension.

Homatropin.—Although we are all accustomed to use this drug so constantly, few accurate observations have so far been made concerning its effect. Fortunately, one member of the Section, Dr. R. L. Crockett of Oneida, N. Y., has taken considerable interest in this question, and sent to the committee the curves produced by his application of 1/50 grain (0.0013 gram) of homatropin to one eye of 4 individuals, and to both eyes of 3 other individuals, making 10 observations altogether. These apparently have been worked out with much exactness. Without going into details, it may be said that this amount of homatropin produced an effect on the accommodation not unlike that of atropin. This effect was not apparent, except in one individual, within the first 10 minutes after the application, but at the end of 15 minutes the accommodation had begun to relax decidedly, and this continued in an almost constant ratio until the end of 35 minutes. In most of the cases there remained at that time only about 1 or 1 1/2 diopter of accommodation available, and by the end of from 45 to 50 minutes complete cycloplegia resulted. Unfortunately, no data were given as to the rapidity with which the effect disappeared, and it still remains for some one to establish that curve. The practical fact is that the evidence thus far at our command seems to indicate that a disc of homatropin of that strength is sufficient for all practical purposes unless some spasm of accommodation is present.

Eserin.—Through the careful observations of Donders, we have long known the effect of a moderate dose of calabar bean on the ciliary muscle. But as the pathologic conditions which we recognize as insufficient accommodation and as excessive accommodation are recognized in part by the behavior of the ciliary muscle after the application of a given quantity of eserin to the conjunctiva, it seemed desirable to ascertain whether a relatively large or a small amount of this drug produced curves which differed materially from the curves given by Donders.

For this purpose, Dr. H. H. Martin of Savannah applied eserin in varying strengths to the eyes of a young man of 18. Without giving the details of these observations it would seem that the effect of the 1/1000 of a grain was more marked than the one of 1/2000, and both of these in turn were more marked and lasted a longer time than did the 1/10000 of a grain. The bearing of this, as already stated, is probably of some importance in connection with the diagnosis of insufficient or excessive accommodation.

NORMAL POSITION OF VISUAL AXES

Passing from the ciliary muscle and the effect of drugs on it to the extraocular muscles, it seemed desirable to our Committee to obtain a few more data concerning the normal position of the visual axes when a pair of eyes is at rest and fixed on a distant object directly in front and in the horizontal plane. This is, of course, a re-examination of the measurements made by Bannister on soldiers, and later by the chairman of this committee on soldiers alone, or by him with Dr. C. H. Williams of Boston on other normal eyes. Accordingly a plan was suggested by the Committee in which the tests would be as nearly uniform as possible.

We have reports on this point from Dr. M. V. Ball of Warren, Pa., who examined 38 pairs of normal eyes; from Dr. H. W. Cowper of Buffalo, who examined 22, from Dr. H. C. Parker of Indianapolis, who examined 13, and from Dr. Oscar Wilkinson of Washington, D. C., who examined 4. The details of these examinations would furnish data for a long paper, and are well worthy of publication. It is especially interesting to observe that certain forms of heterophoria can exist in normal eyes in quite a high degree without giving rise to headaches or other symptoms. But, on the other hand, it would seem that when the muscular tone of the individual, as shown by several tests, is sufficient to overcome the heterophoria, then the complaints of the individual are apparently proportionately lessened. Here it is impossible to refer to such details; we can only state briefly that while orthophoria is found to exist in a decided majority of cases (55 per cent. of normal eyes) a well-marked esotropia is often present (32 per cent.), and occasionally exophoria (4 per cent.). The vertical phorias are by no means uncommon (7 per cent.) either alone or combined with some forms of the lateral phorias.

MINIMUM AND MAXIMUM DUCTION, ESPECIALLY OF THE LATERAL MUSCLES

This means the results obtained by use of prisms according to different methods.

It was found some time ago that in testing for diplopia, if we begin with prisms strong enough to produce the double images and pass from these strong prisms to those which are weaker, and allow a certain time to elapse between the application of one prism and the next, or if we select prisms from the case, or use prisms in series which also necessitate each time a distinct change in the muscular adjustments, we reach a certain point in the strength of the prism just sufficient to produce the double vision. The limit obtained by this method has been called "minimum duction." For adduction, it has been found by such tests to be about 6 or 8 degrees, and for abduction from about 4 to 6 degrees. These results in normal eyes seem to be fairly constant.

On the contrary, if we begin with prisms which are not strong enough to produce double vision, and pass gradually to stronger prisms, *not* allowing a certain time to elapse between the application of one prism and the next (as can be done best if we use the revolving prism of Crété or of Risley), it has been found that the results obtained by this method are quite different from those obtained by the other method. This result has been called the "maximum duction." Thus adduction can often be carried up slowly with the revolving prism to 10, 15 degrees or more, and abduction to 8, 10 degrees or more. It is by no means so constant as the minimum duction, varying considerably not only in different individuals, but in the same individual at different times.

Until recently, the possibility of obtaining different results by using different methods was quite overlooked, and the consequence was that the utmost confusion prevailed in methods, and therefore in results.

But at the meeting of this Section in 1906 a resolution was adopted by which we agreed when testing to pass from stronger to weaker prisms—that is, to obtain the minimum duction, or if not thus tested to state the method used. During the past year, several studies have been made to verify or disprove the necessity of this action by the Section. These studies were made by Dr. Frank A. Morrison of Indianapolis, Ind. (26 persons), by Dr. J. W. Scales of Pine Bluff, Ark. (5 persons), and by Drs. H. C. Cowper and F. J. Barrett of Buffalo, N. Y. together, 22 persons. The results of these examinations, like those of the preceding groups, are well worthy of special consideration. Doubtless some of the details of this group of examinations will be published separately. In this report, however, it is only possible to make a brief statement.

(*a*) When we make tests with prisms, beginning with those which are strong enough to produce diplopia and reduce the strength gradually, we find almost invariably that the resulting minimum duction is less than when we begin with weak prisms and pass gradually to those which are stronger.

(*b*) If we gradually increase the strength of the prism, thus exercising a certain group of muscles in a pair of normal eyes, it is almost always possible to educate, as it were, that group of muscles to overcome those prisms. This indicates, so far as such limited data can, that so-called "latent" convergence, divergence, etc., are not always pathologic conditions, if they are at all, but are rather the results of increased strength produced by the exercise with prisms.

The committee desires to call special attention to the fact that several other studies of the physiology of the muscles have been made, but that it is impossible to make any reference to them at present. This is because some of the communications are too incomplete, or because they deal rather with theories than with "demonstrations which can be seen and photographed if desired or with results of measurements which can be expressed in figures." Moreover, a portion of the data must be reserved for another year simply for lack of space, as this report is already much longer than the committee considers usually desirable.

SUMMARY OF THESE OBSERVATIONS

The results obtained by this study of the anatomy and physiology of the ocular muscles can be summarized briefly as follows. We have:

First.—Corroborative evidence concerning the check ligaments, sufficient to warrant a definition of their extent.

Second.—Corroborative evidence of the existence and extent of the secondary insertions of the ocular muscles. All will probably now agree as to their clinical importance.

Third.—A few more exact dissections of the ciliary ganglion.

Passing next to physiology we have:

Fourth.—Corroborative evidence as to the power of accommodation with parallel visual axes.

Fifth.—New curves of the effects of cocain, showing the important fact that it has a cycloplegic action.

Sixth.—A curve for the action of homatropin, 1/50 of a grain.

Seventh.—Curves indicating that various strengths of eserin produce varying curves, showing its effect on the accommodation.

Eighth.—Corroborative evidence that orthophoria for the far point exists only in a small majority of cases.

Ninth.—There is a difference between minimum and maximum duction, the former being quite constant. the latter not ordinarily constant.

Although these data are not numerous they indicate that perhaps a little has been done to give us rather more exact definitions concerning one or two essential points. They also add a few corroborative facts as to some points about which we needed additional light.

RECOMMENDATIONS OF THE COMMITTEE

For next year the recommendations of this committee are as follows:

1. The studies of the anatomy and physiology of the muscles already begun should be continued.
2. If other members of the Section become interested in these questions of anatomy or physiology, their cooperation should be enlisted.

3. As a large number of members of our Section who originally signified their willingness to cooperate in this work temporarily withdrew from it because they could devote themselves only to questions of pathology, as we are now ready to begin with the more fundamental problems of that kind, and as anomalies of accommodation often exert an important influence on the extraocular muscles, especially those involved in convergence, this committee would also recommend that members of the Section who care to study the muscles should turn their attention during the next year to pathologic conditions of the ciliary muscle.

In doing this the principal points would be to ascertain::

A. What are the most reliable methods for measuring the degree of excessive accommodation (spasm)?

(*a*) Is there present actual excessive accommodation—that is, excessive accommodation in eyes with practically normal refraction? Or

(*b*) Relative excessive accommodation—that is, a normal accommodation with abnormal refraction, especially myopia and myopic astigmatism, or some degree of hypermetropia or hypermetropic astigmatism?

(*c*) What curve represents the range of accommodation when this range is plotted on a system of coordinates?

(*d*) How is this curve changed by a weak dose of atropin, for example, 0.00001 gram (1/5000 grain)?

(*e*) How is this curve changed by a weak solution of eserin, for example, 0.00001 gram?

(*f*) What is the static and dynamic condition of the extraocular muscles, and especially what curve or line represents the relative convergence in each such case?

(*g*) Are there any characteristic vertical or horizontal wrinkles present in the forehead of the individual?

(*h*) What are the subjective symptoms—especially, is the headache frontal, in the vertex, in the occiput, or does the pain extend to the shoulders?

(*i*) What other or better methods are there for measuring excessive accommodation, or what other symptoms are there to indicate its presence?

B. What are the most reliable methods for measuring the degree of insufficient accommodation (paresis)?

(*a*) Is there present actual insufficient accommodation—that is, insufficient accommodation in eyes with practically normal refraction? Or

(*b*) Relative insufficient accommodation—that is, normal accommodation with abnormal refraction, especially hypermetropia or hypermetropic astigmatism, or some degree of myopia or myopic astigmatism.

(Also give the remaining aspects of the condition, as above, for excessive accommodation.)

C. The committee would also recommend that any member of this Section who cares to join in this part of the study give his address to the Chairman. Blanks would be sent on which the desired data could be properly entered, or, if members request it, suggestions will be made as to the bibliography of the different phases of the subject.

LUCIEN HOWE,
HOWARD F. HANSELL,
THEODORE B. SCHNEIDEMANN.

MEMORANDA

MEMORANDA

REPORT OF THE COMMITTEE FOR THE STUDY OF THE RELATION OF TUBERCULOSIS TO DISEASES OF THE EYE*

WILLIAM H. WILDER, M.D.
Chairman of the Committee
CHICAGO

This committee was formed for the purpose of studying in a cooperative way the relation of tuberculosis to certain diseases of the eye, the etiology of which is often obscure.

As was stated in the preliminary report, it was thought that a number of observers might accumulate enough data to draw conclusions that might not be warranted by the limited observations of a single individual.

Those who were interested in this work agreed to study their cases acording to a plan that was prearranged, and to keep records on blanks prepared for the purpose, so as to facilitate compilation.

This plan of study contemplated a thorough physical examination of the body to determine, if possible, the etiology of the eye disease. If, in this examination, no reasonable etiology could be determined, other than that the patient gave evidence of having either active or quiescent tuberculosis in some part of the body, it would be strong presumptive evidence that tuberculosis played some rôle in the causation of the eye disease.

Unfortunately, it is difficult to control clinic and dispensary patients as one would like; and it is also difficult to exclude syphilis, blood conditions, autointoxications and other factors, in order to get perfectly definite results in such a problem. But if we can place any reliance in the tests that have been proposed by Koch, Wolff-Eisner, Pirquet and Calmette, it is not difficult to determine whether or not a person is tuberculous, even in the absence of well-defined physical signs.

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* This paper has been accepted by the Executive Committee of the Section on Ophthalmology of the American Medical Association, to be presented at the St. Louis Session, June 7-10, 1910. Publication rights reserved by the American Medical Association.

It is one thing, however, to show that an individual is tuberculous and quite another to prove that the lesion of the eye that he has is tuberculous; and yet, while there may be lacking the positive proof, the presumptive evidence may be strong.

Such is the case when, in addition to the general reaction, from the subcutaneous injection of tuberculin, there appears a reaction in the affected eye, manifested by a conjunctival or ciliary injection or an aggravation of the original trouble. This has been done in many cases, when feasible; in many of them we had to rely on the physical examination or the simpler cutaneous test of Pirquet.

There has been a growing distrust and fear among ophthalmologists of the use of the conjunctival test, proposed by Wolff-Eisner and Calmette, that I think is not altogether well founded.

Most of the members declined to make use of the Calmette test in this study, because they consider it dangerous. It is true that certain ill effects from the use of tuberculin in this way have been observed, and the alarm has been sounded by several oculists of note, but I am inclined to think the reason for the bad results is that the solution has been used too strong at first. It is as necessary to know just what strength one may use with safety in the conjunctiva as it is to know what dose one may safely administer subcutaneously.

Within the past year I have made observations in a number of cases of eye disease that I had reason to believe were tuberculous in nature, and found that not only did the patients tolerate tuberculin administered in the eye in small doses, gradually increased, but they actually improved as I approached the dose that would excite a mild reaction. To be on the safe side, the first dose would be 1/1000 mg., gradually increased until in some cases 1/10 mg. would be employed, a dose nearly equal to that ordinarily employed in the Calmette test.

These cases will be made the subject of a personal communication later, after further observation and study.

The following members of the committee have submitted records of cases that are included in this report: Drs. George S. Derby (Boston), Charles Stedman Bull, Arnold Knapp (New York), W. C. Posey, George E. de Schweinitz (Philadelphia), Harry Friedenwald (Baltimore), L. W. Dean (Iowa City), and W. H. Wilder.

For various reasons, other members of the committee were prevented from engaging in the work, so that the showing is not so large as we had hoped to have it, but altogether we have 144 cases to report that have been studied with a view to deter-

mining whether tuberculosis played any rôle in the etiology. These cases have been classified as follows:

Blepharitis	3
Dacryocystitis	2
Follicular conjunctivitis	5
Phlyctenular disease of conjunctiva and cornea	47
Scrofulous pannus	4
Keratitis (deep and nodular)	12
Interstitial keratitis	18
Episcleritis	4
Scleritis	3
Sclero-keratitis	22
Chronic iritis	3
Chronic iridocyclitis	7
Uveitis	6
Chorioiditis	5
Chorioretinitis	3
Total	144

BLEPHARITIS

Bull: Case 1.—Boy, aged 4; in upper right lid a small nodule appeared, which increased in size to that of a small pea and became red and painful; no enlarged glands; lungs and other parts normal. Von Pirquet test negative after three trials. Subcutaneous test, decided general reaction; temperature 100.4 F.; no local reaction.

Case 2.—Girl, aged 15, had a small nodule in middle of lower right lid that extended into conjunctiva, ulcerated and bled easily. Von Pirquet test negative; subcutaneous test positive. Temperature 100.2 F.

These cases were regarded as tuberculosis of the lid.

Wilder: Girl, aged 6, with blepharitis ulcerosa. Tonsils enlarged, adenoids present, superficial lymph glands enlarged. Reason to believe that child was tuberculous, but three v. Pirquet tests negative.

DACRYOCYSTITIS

Wilder: Case 1.—F., aged 19; fistula in tear sac. Lymphadenopathy. Marked reaction to v. Pirquet test.

Case 2.—F., aged 9; chronic dacryocystitis; appears tuberculous. Pulmonary examination negative. Three v. Pirquet tests negative.

FOLLICULAR CONJUNCTIVITIS

Wilder: Five patients, ranging in age from 1½ to 15 years. In all these cases perceptibly enlarged lymphatic glands. In all pulmonary examination negative; v. Pirquet test positive in three and negative in 2.

PHLYCTENULAR CONJUNCTIVITIS AND KERATITIS

Derby: Eleven patients, 9 under 14 years of age, 1, 28 and 1, 30. In 8 unmistakable clinical signs of tuberculosis; 5 of the lungs, 1 of the spine, 1 of the knee and spine, and 1 of the skin. The other 3 cases showed signs of scrofula in enlarged glands. Five cases showed a positive and severe reaction to v. Pirquet test; in the other 6, test not made, the evidence being so strong that they were tuberculous. Patients were treated in the tuberculous class.

Wilder: Thirty-six patients with phlyctenular disease of the cornea and conjunctiva, ranging in age from 2 to 21 years, only 5 being over 14 years. Of the 36, 7 showed signs of active or quiescent pulmonary tuberculosis, I had history of tuberculous spine and showed kyphosis. With two exceptions, a well-nourished child of 7 years and a woman of 21, all had enlarged superficial lymphatic glands varying in degree. All but 4 of the 36 reacted positively to the v. Pirquet test. In one of these, a healthy boy of 8, with only slight adenopathy, and a phlyctenular conjunctivitis of right eye, two Calmette tests were negative and three v. Pirquet cutaneous tests were negative. In a woman, aged 21, with good history and no enlarged glands, two v. Pirquet tests were negative. In 2 other cases, a woman of 20 and a girl of 3, one test was negative, although there were evidences of scrofula in both of them. Possibly, if the patients had returned for repeated tests, the reaction might have been positive.

In this category may be included the cases denominated scrofulous pannus, in which extensive phlyctenular disease involves large areas of the cornea, and is very obstinate to treatment.

Four of these cases were studied, of which none showed pulmonary lesions, but all had marked lymphadenopathy and responded positively to the Pirquet test with severe reaction. One of these, a colored woman of 28, with an obstinate extensive phlyctenular keratitis of five months' duration, improved remarkably with tuberculin dropped into the eye in graduated doses.

Summary.—Fifty-one cases of phlyctenular disease of the cornea or conjunctiva, or both; 47 at least showed distinct evidence of tuberculosis, either in a quiescent or an active form.

INTERSTITIAL KERATITIS

Only those cases were considered in which with reasonable certainty syphilis could be excluded; 18 such cases were studied.

de Schweinitz: In a girl of 18, with bilateral interstitial keratitis, a general reaction was obtained and also a local eye reaction after subcutaneous test with tuberculin.

Dean: In 2 patients examined, 14 years and 46 years, one showed a positive v. Pirquet, the other was negative. Neither responded to general test.

Knapp: Three patients, 11, 18 and 23 years, all reacted to subcutaneous test, and two showed a local reaction in the affected eye, in the increased ciliary injection, or aggravation of the symptoms. The one who showed no local reaction, but a distinct general reaction, with temperature of 101 F., improved decidedly on antisyphilitic treatment. The Wassermann test was not made.

Derby: Seven patients, ranging in age from 16 to 36 years. Five showed marked general reaction to subcutaneous test with tuberculin, with local reaction in the affected eye. This local reaction was an aggravation of the symptoms of mild degree, but was considered positive by the observer.

In one case, a girl of 16, with bilateral keratitis interstitialis, there was a quiescent tuberculous process in both apices. Wassermann test was negative, but patient gave no response after two trials of the v. Pirquet test. Dr. Derby concludes, however, that the case is tuberculous. In the other case, a girl of 19, there was tuberculosis of both apices, old tuberculosis of cervical glands, and yet the v. Pirquet test was twice negative.

WILDER: Five patients, ranging in age from 6 to 25 years. Four showed distinctly positive reaction to v. Pirquet test. One who reacted negatively on first examination was a delicate child of 8, with scrofulous glands and a suspicion of beginning pulmonary trouble, and did not return for further examination. Two of the patients tested with tuberculin subcutaneously showed general reaction and a slight reaction in the affected eye.

Summary.—Eighteen patients; 11 showed general reaction to subcutaneous test; 3 others showed positive v. Pirquet test. In the 4 who were negative to v. Pirquet, tuberculosis was thought to exist in 3 of them from clinical examination. Of the 11 who showed reaction to the subcutaneous test, 9 showed a local reaction in the affected eye, evidenced by increased ciliary injection or an aggravation of the conditions.

KERATITIS

Of other forms of keratitis suspected of being of tuberculous origin, 12 cases have been studied.

DE SCHWEINITZ: A man of 25 years, with nodular opacites in the anterior layer of the cornea, reacted to subcutaneous test with local reaction in affected eye. Tuberculin treatment seemed to relieve him, but vision was not improved.

DERBY: Eight patients, ranging in age from 10 to 49 years, in whom there were nodular infiltrates in the cornea, several in the deeper layers, and in 3 combined with nodules in the iris. In 4 of these patients there was evidence of pulmonary tuberculosis, in 2 others a family history of tuberculosis, and in 2 no pulmonary involvement or noticeable lymphadenopathy. In all of these cases but one there was positive and marked reaction to the v. Pirquet test. This patient, a man of 32, with kerato-iritis, had nodules in the cornea and one in the iris angle that looked tuberculous. Pulmonary examination was negative; no lymphadenopathy.

WILDER: Two patients. Woman, aged 27; no pulmonary trouble; fair health; deep nodules in cornea; v. Pirquet test positive. Man, aged 40; fair health; evidence of old tuberculous trouble in each apex; nodules in superficial layer of cornea that broke down and formed small ulcers; v. Pirquet test positive. Subcutaneous test gave marked general reaction and local reaction in affected eye. Scrapings from ulcers showed no bacilli and cultures were negative. Tuberculin dropped in conjunctival sac, in graduated doses, followed by healing of ulcers and fair clearing of the cornea.

BULL: Woman, aged 19, frail, anemic, some enlarged glands. Infiltration of inferior segment of cornea, with small, yellowish nodules, and thickening and nodular elevation of adjacent conjunctiva. Pulmonary examination was negative; v. Pirquet test positive, with increased temperature. Subcutaneous test gave general reaction and temporary aggravation of condition of eye.

Summary.—Of 12 cases of nodular keratitis, 11 showed evidence of tuberculosis. In 5 pulmonary tuberculosis was demonstrated. In 3 tested subcutaneously there was general reaction, with local reaction in the affected eye.

EPISCLERITIS

DEAN: Woman, aged 26, in fair health, developed episcleritis in right eye two days after conjunctival test with tuberculin, but, according to the observer, independent of it. Von Pirquet test was positive, subcutaneous test positive; temperature 102 F. after 1 mg. of tuberculin.

WILDER: Three cases. Case 1.—F., aged 18. Father died of pulmonary tuberculosis. Slight apex lesion; cervical glands enlarged; right eye affected for seven months with a nodule in episclera on temporal side; v. Pirquet test positive; Calmette test in other eye positive. Treatment with tuberculin in conjunctival sac, maximum dose being 7/1000 mg. Recovery.

CASE 2.—F., aged 36; fairly healthy; lungs negative; episcleral nodule on temporal side of right eye; v. Pirquet test positive.

CASE 3.—M., aged 24; fairly healthy; superficial glands enlarged; episcleral nodule in temporal side of left eye for six weeks. Von Pirquet test positive and marked; greatly improved by tuberculin injection in conjunctival sac; maximum dose, 5/1000 mg.

Summary.—Four cases, of which 1 showed evidence of pulmonary tuberculosis, 1 responded to subcutaneous test, 2 responded to v. Pirquet test.

SCLERITIS AND SCLEROKERATITIS

BULL: Two cases of scleritis in patients of 5 and 12 years. In each there was a nodule in the sclera, about 8 or 10 mm. in diameter. In one the conjunctiva over the scleral nodule had ulcerated; no organisms were found in the scrapings. There was some lymphadenopathy, but no pulmonary lesions. Subcutaneous test in each case was positive, and in the affected eye there was an increase of vascularity.

KNAPP: One case of deep scleritis in one eye in a patient of 27 years; no enlargement of glands or pulmonary trouble. Subcutaneous test gave positive reaction, and a little more redness of the bulbar conjunctiva.

DE SCHWEINITZ: Three cases of typical relapsing sclerokeratitis in adults, in all of whom the v. Pirquet test was positive, and in two of which brilliant results were obtained with tuberculin treatment.

FRIEDENWALD: One case. F., aged 18; sclerokeratitis with iritic complication; suspicion of pulmonary lesion at apex. Von Pirquet test was positive; subcutaneous test positive; good result from tuberculin treatment.

POSEY: Two cases of sclerokeratitis in persons, 33 and 28 years of age, in good health; no glandular or pulmonary involvement. In both v. Pirquet test was positive; in both subcutaneous test was positive and in one there was pronounced local reaction in affected eye; good results from tuberculin.

Derby: Fifteen patients ranging in age from 24 to 50, in 4 of whom the iris was involved. Seven gave physical signs of pulmonary tuberculosis, and in most of these there were also signs of tuberculous glands. In 8 physical examination was negative, except slight lymphadenopathy in 2. In 9 cases, the v. Pirquet test was made and was positive. In 5 in whom a subcutaneous test was made it was positive, and all except one of these were in persons who showed no physical signs of tuberculosis except slightly enlarged glands in 2. In 3 of these 5 cases of positive subcutaneous reaction there was also a pronounced reaction in the affected eye; in the other 2 the administration of a therapeutic dose of 6/100 mg. caused a light general reaction as well as a mild reaction in the affected eye.

Wilder: One case, a woman of 23, with enlarged glands, but no pulmonary involvement. Von Pirquet test was positive; Calmette test in sound eye was positive; subcutaneous test, 3 mg. caused marked general reaction, with slight reaction in affected eye. The patient, who had suffered for months, improved remarkably after use of tuberculin in increasing doses in the conjunctival sac, the maximum dose reaching 1/10 mg.

Summary.—Twenty-five cases of scleritis and sclerokeratitis, in 8 of which physical examination showed signs of pulmonary tuberculosis. In 12, the subcutaneous test was made and was positive, and in 10 of these there was reaction in the affected eye, manifested by an increased redness or a distinct aggravation of the condition. In the 13 remaining cases all but one gave evidence of the existence of tuberculosis by a positive Pirquet reaction. In 9 cases it is noted that marked improvement followed the use of tuberculin.

CHRONIC IRITIS

Bull: F., aged 15; previous history of iritis one year before. Left eye shows three nodules in iris, one larger than the other; post-synechiæ. Glands in neck enlarged; pulmonary examination negative; v. Pirquet test positive, with temperature increased to 100 F. Subcutaneous test positive, 101.6 F., with local reaction in eye.

Wilder: Case 1.—M., aged 37. Had repeated attacks of iritis in each eye. R. V. = fingers three feet. Severe iritis. L. V. = 20/40 +. L., post-synechinæ. Von Pirquet test positive; subcutaneous positive; reaction in eye questionable. Treated with tuberculin in conjunctival sac, with increasing doses, reaching a maximum of 1/10 mg. Improvement of condition of right eye and vision reached 20/200.

Case 2.—F., aged 8; chronic iritis of right eye for one year. Fifteen months before she was seen, eye had been struck by a stick, but without a penetrating injury. Marked lymphadenopathy; marked v. Pirquet reaction, with a general reaction; no noticeable change in eye.

Summary.—Three cases of recurrent iritis, all of which gave evidence of existence of tuberculosis.

CHRONIC IRIDOCYCLITIS

Dean: Case 1.—Male, aged 25; iridocyclitis and anterior chorioiditis; no enlargement of glands; pulmonary examination negative. Positive Calmette test; positive subcutaneous test after 5 mg. of O. T.; temperature 103.6 F.; marked reaction in affected eye, lasting three weeks; no improvement with tuberculin.

Case 2.—Adult male; chronic iridocyclitis in right eye; left eye lost from previous attacks of inflammation. R. V. = F. 1 m. Glands negative; pulmonary examination negative; v. Pirquet test positive and severe; subcutaneous injection positive. Eye seemed to improve after 3 mg. and 5 mg. injections. After eight months of treatment with tuberculin, R. V. = 6/8.

Case 3.—Female, aged 24; severe pain in right eye; V. = P. 1. Left eye was removed at age of 16 from result of an injury in childhood. Glands not enlarged; lungs normal; v. Pirquet test negative; subcutaneous test negative, 5 mg.

Case 4.—Chronic iridocyclitis, and keratitis bullosa of right eye in adult male. Cataracts had been extracted 14 years before. R. V. = fingers, 6 inches. Von Pirquet negative; subcutaneous test negative.

Knapp: Male, aged 17. Mother died of pulmonary tuberculosis. Iridocyclitis of left eye; L. V. = 15/200; slight lymphadenopathy; slight involvement of lung. Subcutaneous test positive; temperature, 100.4 F.; no reaction in eye.

Wilder: Case 1.—Female, aged 30; frail woman; rheumatic history. Numerous deposits on back of each cornea; gradual failure of vision and distress in eyes. Subcutaneous test, 3 mg., gave distinct general reaction and slight reaction in right eye; no marked improvement of vision under tuberculin treatment.

Case 2.—Male, aged 19, chronic iridocyclitis of left eye. Injury of eye 10 years before, from which he recovered with good sight; gradual failure of vision, with precipitates on back of cornea; opacities in vitreous; general condition good; pulmonary examination negative. Von Pirquet test positive; subcutaneous test, 1 mg., positive; temperature 102 F., with local reaction in affected eye. Vision gradually failed; tuberculin treatment ineffective.

Summary.—Seven cases of chronic iridocyclitis and anterior chorioiditis, in only 1 of which was there evidence of pulmonary tuberculosis. In 5 there was general reaction to tuberculin subcutaneously and in 3 of these slight reaction in affected eye.

UVEITIS

Bull: Male, aged 30, anemic; iris swollen and discolored; post-synechiæ; opacities in vitreous of two months' duration; no pulmonary disease; glands normal; v. Pirquet test positive; subcutaneous test positive; temperature 102 F. In eye all symptoms were increased in severity.

de Schweinitz: Female, aged 22; relapsing uveitis, very suggestive of tuberculous origin. Tests for tuberculosis were entirely negative. Subsequent treatment along the line of intestinal autointoxication was most successful.

Wilder: Four cases. Case 1.—Male, aged 23; general health good; enlarged lymph glands in neck; no pulmonary trouble; recurrent attacks of dimness of vision of right eye; post-synechiæ; vitreous opacities. R. V. = 14/200. Later this fell to perception of light. Subcutaneous test positive; temperature, 101.6 F.; reaction in eye. Continued tuberculin treatment improved condition, so that V. = 20/40.

Case 2.—Female, aged 40; fair health; in both eyes uveitis with iritis; old patches of chorioiditis; recurrent attacks of redness of eyes and dimness of vision; at times precipitates on back of cornea. Subcutaneous test, 5 mg., general reaction, with no local reaction in eyes.

Case 3.—Male, aged 49; good general health; uveitis in both eyes, began in right four years before; vitreous opacities, followed by detachment of retina and blindness; failure of vision of left eye, V. = 14/200; no iritis, but numerous opacities in vitreous. Von Pirquet test positive and marked; subcutaneous test, 3 mg., positive; general reaction and local in eye. Treatment with tuberculin relieved for a time.

Case 4.—Female, aged 62; fair general health; pulmonary examination negative; history of general uveitis in both eyes, with iritis, vitreous opacities and gradually increasing opacities of the cornea; v. Pirquet test positive; no subcutaneous test.

Summary.—Six cases of general uveitis, with no physical signs of tuberculosis. Four cases gave positive reaction to subcutaneous test, with local reaction in affected eye in 3.

CHORIOIDITIS AND CHORIORETINITIS

de Schweinitz: Male, aged 18; relapsing chorioiditis and vitreous hemorrhages; negative v. Pirquet test; marked intesinal autointoxication and relief from treatment along this line.

Posey: Male, aged 25; family history negative; fair health; signs of old tuberculosis in left apex. Right eye: hazy vitreous; descemetitis; yellowish mass in chorioid; subcutaneous test positive; temperature, 102 F. Local reaction could not be ascertained on account of inflammatory condition. Tuberculin treatment and general measures resulted in cure. V. = 5/20.

Dean: Male, aged 21; good health; right eye lost in infancy from chorioiditis; left chorioiditis for six months. v. Pirquet test positive; no subcutaneous test used.

Knapp: Three cases. Case 1.—Male, aged 29, with disseminated chorioiditis in both eyes; no family history; pulmonary examination negative; no enlarged glands; disseminated patches of chorioiditis in each fundus; lowered vision. Subcutaneous test positive, 1 mg.; temperature, 104.2 F., with ciliary injection in each eye.

Case 2.—Adult male, in good physical condition; family history negative; chorioiditis exudativa in right eye; V. = 10/200; post-synechiæ; shallow retinal detachment. Subcutaneous, 1 mg.; general reaction; temperature, 104 F.; and conjunctival and ciliary injection.

Case 3.—Male, aged 15; no pulmonary signs; no gland enlargement; in macular region of both eyes, large areas of chorioidal change. R. V. = 20/200; L. V. = 12/200. Subcutaneous test, 5 mg.; temperature, 101.8 F.; positive; no reaction in eye.

DE SCHWEINITZ: Girl, with form of retinal disease, with extensive exudate, simulating tuberculous disease; subcutaneous test negative.

WILDER: Female, aged 18, failure of vision of both eyes at age of twelve; fair health; no evidence of syphilis; chorioretinitis in each eye; media normal. R. V. = 10/200; L. V. = 5/200. Von Pirquet test three times negative.

Summary.—Six cases of chorioiditis, in 4 of which subcutaneous test gave a positive general reaction, with local reaction in the eye in 2. Two cases of retinitis or chorioretinitis, in which tuberculin tests were negative.

In trying to arrive at some definite conclusions as to etiology in a group of cases like the foregoing, one should consider carefully the relative value of the means and tests employed in the examination of such cases. If active tuberculosis is present or has been present in lungs, joints or bones, sufficient to cause any marked changes, the condition may be discovered with all reasonable probability by careful physical examination. But if from 90 to 98 per cent. of all persons who have reached 60 years of age have been at some time infected with tuberculosis, as is claimed, then very many have suffered so slightly as not to present signs of the disease that can be determined during life by our methods of physical examination.

If from 90 to 95 per cent. of all persons who have passed the adolescent period of life will respond actively to the sensitive cutaneous test of v. Pirquet, as is claimed, it helps to confirm the statements of the pathologists as to the ubiquitous nature of the disease. This being so, in a given case of eye disease, one could place little reliance on this test as determining the actual etiology of the eye lesion without first positively excluding all other factors, and this is not always possible.

The same criticism would apply to the Calmette test which, on account of its danger in diseased conditions of the eye, one would hesitate to use for ophthalmic diagnosis, even if one eye were sound. Response to this test might prove, as is claimed, the existence of active tuberculosis in some part of the body, but would not necessarily determine the nature of the eye lesion.

In the test by subcutaneous injection of tuberculin, the same difficulties are encountered. A general reaction following this test would only prove that the individual is tuberculous (excluding syphilis, leprosy, actinomycosis), which might be done by the simpler v. Pirquet or Calmette test. If, however, a local reaction in the diseased eye occurs, manifested by ciliary injection, conjunctival redness, or marked aggravation of the previous condition, we have strong presumptive evidence that the lesion in the eye is tuberculous. But the eye may be so inflamed as to prevent us from observing whether or not there is increased reaction, so that the test, if made, should be made when the eye is in a comparatively quiet condition.

Again, this raises the important question whether such structures as the cornea, sclera and uvea may not be thrown into a diseased condition by the toxic substances from the bacilli in a distant focus of tuberculosis, reaching them through the blood and lymph channels, without the presence of the micro-organisms themselves in any part of the eye. This being the case, might we expect a local reaction in the eye, even if we encountered a general reaction with the subcutaneous test?

An interesting feature of this series of cases is the frequency of association of tuberculosis in some part of the body with eye conditions, such as phlyctenulosis, deep and interstitial keratitis (non-syphilitic), and sclerokeratitis, and the frequency of local reaction in the eye in such cases, with the use of the subcutaneous test.

In 59 cases of keratitis, episclerotis, scleritis and sclerokeratitis, 56 gave positive evidence of being tuberculous, either by physical examination or tuberculin tests. In 27 of these cases subcutaneous tests were made, and of these 22 were positive as to local reaction in the eye.

If it were possible to study all such cases that appear in a year or two in several large clinics or eye hospitals, we might arrive at some instructive conclusions as to the frequency of tuberculosis as a cause of such diseases.

MEMORANDA

TESTS OF VISUAL ACUITY

AND CARDS FOR SUBJECTIVE CORRECTION OF AMETROPIA *

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The testing of visual acuity and the measurement of ametropia by the improved vision obtained by test-lenses are two distinct processes, which will be best carried out by different forms of apparatus. In testing visual acuity we need only to determine a single "minimum separabile," which is done most simply by finding the greatest distance at which a test of known visibility can be recognized. In the subjective measurement of ametropia we have to provide for a "minimum separabile" progressively diminishing as the accurate correction of the refractive error is more nearly approximated. This requires a series of test-objects progressively diminishing in size, such as the ordinary test-cards furnish.

STANDARD OF VISUAL ACUITY

The adoption last year at the Naples ophthalmologic congress of the report of the committee appointed at the preceding ophthalmologic congress at Lucerne to propose an international standard of normal visual acuity, with the discussions of the subject that have arisen from that report, make the present an appropriate time to consider this important subject.

The international report fixed normal visual acuity as the ability to recognize two points separated by an angle of one minute; and chose as the test of this ability the so-called "broken ring," a black circle on a white ground, the black line having a width one-fifth its outside diameter, and the break in the black ring having just its width. Such a ring, when placed at such a distance

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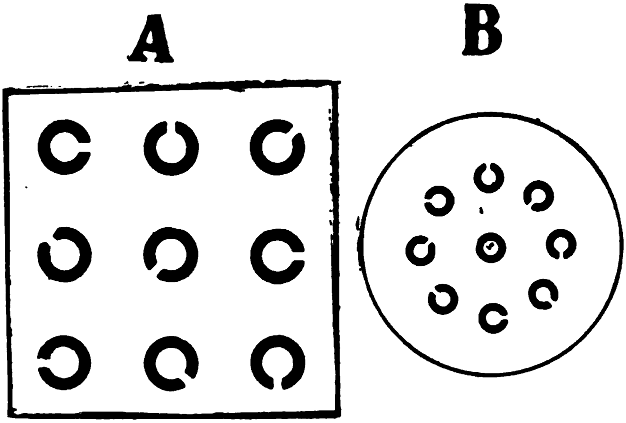
that its total diameter subtends an angle of five minutes, gives a break in the ring that subtends an angle of just one minute; and the ability to tell in what direction the break or gap is placed indicates normal visual acuity.

The principle of the "minimum separabile" and its normal value of one minute were announced and pretty well established as the proper theoretic basis for sight testing by Roger Bacon over two hundred years ago. On strict analysis it is found to underlie most of the tests for visual acuity that have been suggested since. At the Nashville meeting of the American Medical Association in 1890, I suggested the use of a black square, each side of which should subtend an angle of three minutes, with a space cut out of one side of the square subtending an angle of one minute, the test being to designate which side of the square was left open. I did not then know of the broken ring advocated by Landolt before the *Societé française d'ophtalmologie* in 1888, which has all the advantages of the incomplete square with this distinct superiority: The ring can be turned in twice as many distinct directions. The square is capable of four different positions; the break in the ring can be turned up, down, right, left, or at angles of 45 degrees, midway between those positions.

If a single broken ring, on a circular card, be shown to the person to be tested, there is but one chance in eight for him to guess correctly in which direction the gap is turned. By concealing the card for an instant and turning the ring differently the test can be repeated indefinitely; and a few repetitions will render it certain that the eye possesses the vision claimed. The test is extremely convenient for examining patients away from the office. If the position of the gap is recognized at a certain distance, the same ring can be again shown at a greater distance until the limit of recognition is reached. A single letter or line of letters cannot be used this way. Any testing of acuteness of vision can be done with such a broken ring on a circular card, that can be carried in the vest pocket, with absolute scientific accuracy. All possible errors from the patient learning the sequence of the letters used as a test and the needed precautions to prevent this are avoided.

For testing the vision of school children, or of men entering a transportation service, a series of broken rings may be used. The sequence of such figures is harder to commit to memory than that of a series of letters or numerals. If the rings are arranged symmetrically on a square card, as in A, either edge of the card can be turned upward. Each way gives a distinct sequence, and it is impossible for the person tested to know which sequence is being used. Or the rings may be arranged in a circle on a circular card, B, and held with either of them at the top.

With such a test-card the test of visual acuity may be repeated until certainty as to the visual acuteness has been reached. If recognized at one distance, the rings can be moved to a greater distance and tried again; things that cannot be done with test letters or numerals. Then, too, such a test can be furnished on a small card easily transported, a very important advantage where large numbers of cards are to be distributed, as for testing the vision of the school children of a county or a state.



International tests; A, visible at 5 meters (about 16 2/5 feet); B, visible at 2.5 meters.

For simply ascertaining the visual acuity the most simple and convenient way is for the person conducting the test to hold the card, and starting from a sufficient distance gradually approach the person to be tested, noting the distance at which the direction of the break is first recognized in the ring to which attention is directed. Such a test may be explained to a whole row of children at once. Then the teacher, stepping back, can proceed to test each of them while all the others look on. The spirit of imitation and that of rivalry are brought out, to aid in overcoming the inertia, which often makes it difficult to induce a child to do his best with a new exercise of this sort.

TO MEASURE AMETROPIA

For the subjective measurement of ametropia by trials with lenses a very different test-card is necessary. The physician must be near the patient to make the needful changes in the lenses; and test-objects that are easily designated as recognized (pre-eminently letters and numerals) are far superior to any others. When we come to arrange a test-card of this kind we have to take account of the fact that the different letters or numerals are not equally easy to recognize. All who have arranged test-cards of letters have had to meet this difficulty. Snellen chose block letters because with them it was possible to approach nearer to equality of visibility. But he and others who have followed him have had to restrict themselves to the employment of certain letters, and even then they have been far from attaining a full equality.

The unequal visibility of letters, however, may be a distinct advantage in measuring refraction. As one letter after another is brought out by successive improvements in the correcting lens before the eye, the one line of letters serves to test various changes of visual acuity. Only when we attempt to use these letters to test acuteness of vision does their unequal visibility become a disadvantage, and we are compelled either to greatly restrict the number of letters employed for our tests or to introduce serious indefiniteness into our results.

A valuable study of the relative visibility of the different letters in the block-letter alphabet was made in this country by Dennett,[1] and within a few months Gebb and Lohlein[2] have reported a study made with letters, numerals and simple geometric figures of different sizes.

The essential point is that we cannot say that letters of a certain size and formation will be just recognized by the normal-sighted at a certain distance until, empirically, we have determined at just what distance they are so recognized. Wherever such objects are used to test visual acuity, it is essential to compare their visibility with that of the international standard broken ring.

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[1] Dennett: Tr. Am. Ophth. Soc., iv, 133 and 245.

[2] Gebb and Lohlein: Arch. f. Augenh., liv, 69 and 189.

This is just what the International Committee did for the few letters and numerals they admitted to their test-chart. This is just what every ophthalmic surgeon can and should do with the test-cards he habitually uses. By making such a comparison and numbering the different lines in accord therewith, without any change in the test-charts we use, we can arrive at uniformity in our records of visual acuteness. But in numbering a line that contains any considerable variety of letters it must be understood that to recognize one or two letters on it means one visual acuity, and to recognize all means a higher visual acuity. It would be of practical value to note at one end of the line what vision it means to recognize two of the letters. and also to indicate what vision is necessary to recognize all, as has been done on the cards referred to below.

In the subjective estimation of ametropia by trial lenses and cards we often proceed by asking the patient whether each change in the lens makes the vision better or worse. This is true subjective testing depending wholly on the patient's honesty and power of accurate discrimination between different visual impressions. But the method may be given much of the value of an objective method by requiring the patient to name the letters or numerals recognized from time to time, the correct naming of one before unrecognized being the best possible evidence of improved vision by a better approximation to the perfect correction.

But for this purpose the test-letters quickly lose their value, when once clearly recognized. They are correctly named from memory when less distinctly seen, and the patient's answers mislead rather than assist in finding the true correction. While the vision is being improved rapidly, and the reading progresses from lines of large letters to those of smaller letters, previously quite unrecognizable, this difficulty does not trouble us. But when nearly the best vision has been reached, when the changes to be made are slight, one line of letters soon ceases to be serviceable, and the only resource left us is to change the test-card.

More series of these smaller letters are needed than of the larger letters. So it seems worth while to multiply the former, without the latter, by having test-cards containing only the smaller rows of letters, for use in the accurate subjective testing of refraction. A series of such test-cards I have had prepared. The small figures at the end of the lines indicate, according to the international standard, the visual acuteness required to recognize the letters. The figure at the right gives the distance at which the letters subtend the angle of five minutes. The figures at the left give the visual acuity required to name two letters on that line, and the visual acuity required for the recognition of all the letters on the line. The size of the letters is such that their heights subtend the angle of five minutes, at the distances of 6, 5, 4 and 3 meters, respectively (about 19 2/5, 16 3/5, 13 1/10 and 9 4/5 feet). These are the distances at which they are supposed to be read according to the Snellen scale.

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MEMORANDA

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PRESCRIBING OF LENSES FOR CLOSE WORK *

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It will be possible to discuss only certain phases of this broad subject. Some procedures do not seem to be sufficiently well known, and require elucidation and emphasis in order to secure their more general adoption by those who prescribe lenses for the eyes. Before considering the prescribing of lenses for close work, the muscle conditions and static refraction for distance should be correctly determined. The latter is usually impossible without the proper use of cycloplegics, except in certain cases of myopia and in some people past middle life whose accommodation is weak or easily controlled. Sometimes the examiner must be satisfied with partial corrections, because fatigued yet determined, hypertrophied, habit-controlled, spasmodically contracting muscles are by no means limited to the young, but are often found in the eyes of the middle-aged with their more inelastic resisting lenses.

There are many young persons who suffer more or less distress, e. g., blurring, eye-ache and even headache after continued close work who experience no difficulty in the ordinary use of their eyes. In such cases it is a common custom to advise the constant use of lenses; during our first years in practice we made it a rule to do so. If there is no fixed vertical muscle imbalance, however, and no astigmatism or only a slight degree, less than .38 D., with weak spheres of nearly similar strength for each eye, the proper distant correction should be worn only for close work if all the symptoms are thereby relieved. In many patients it is more satisfactory to advise constant use of the lenses for the first few weeks or months until unnecessary ciliary contrac-

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* This paper has been accepted by the Executive Committee of the Section on Ophthalmology of the American Medical Association, to be presented at the St. Louis Session, June 7-10, 1910. Publication rights reserved by the American Medical Association.

tion and consequent dimmed distant vision has more or less disappeared, when, if no symptoms remain, the patient may lay aside the lenses except for near work. Patients are often compelled by their advisor's orders to undergo the discomfort of constant use of lenses, although many, after a period of rest, disobey instructions, lay aside their lenses except for close work, discovering that they are comfortable without them. Such patients may lose confidence, and often go one step too far, discarding the lenses altogether for a variable time without discomfort, although possibly injuring the eyes by the added accommodative strain. It must be admitted that certain of these patients are not comfortable without constant use of lenses and it might be argued that in some the ametropia, e. g., astigmatism, is more likely to increase, but this chiefly depends on the individual and his work and can be known only by a fair trial. The oculist should not as a matter of routine advise such patients to wear lenses constantly. Of course, if there is considerable astigmatism or heterophoria present the patient may harm his eyes by not doing so and is not so likely to find comfort in their use for close work only. The eyes of the great majority of young people are hypermetropic, requiring the use of the ciliary muscles for clear distant vision, but such eyes, unless very hypermetropic, do not necessarily suffer distress or impairment of function in doing distant work; it is nearly always the added strain in near work that distresses and injures, especially if there is impairment of the general nervous system or the health.

The use of lenses in close work is often made necessary independent of the condition of the eyes for the distance. This is true when there is any impairment of the general health and vigor weakening the action of the ciliary muscle or influence of the third nerve, e. g., in conditions following various infectious fevers, especially after typhoid and diphtheria, and in certain toxemias and anemias as well as in cases of subnormal accommodation, or ciliary asthenia from other causes. In such cases pure hypermetropia of low degree might require lenses for only close work, while patients with considerable astigmatism or those who require prisms, especially one base up or down, usually should have bifocals. Lenses could be tried for near work, but, since these would not permit good distant vision, bifocals would be particularly helpful, especially in certain vocations, for instance, in that of a student. As the ciliary asthenia disappears the segments may be made weaker or dispensed with, leaving the proper distant lenses for distant and close work. In these cases there is a temptation to give too strong lenses for near work so as to help the patient as much as possible, but this discourages return of function in the weak muscle, although, according to Hess,[1] exercise can have no effect on the maximum of lens convexity. Duane[2] believes that exercise can increase the accommodation when weakened. Such patients should be requested to hold the reading, etc., as far away from the eyes as possible and to give the eyes frequent short rests from close work. Attention to general treatment and hygiene is very important, and posture, position, intensity of lights, etc., should not be neglected.

In myopia of about the same degree in each eye, over .50 D. and less than 2.00 D. or 3.00 D., and with little or no astigmatism, it is often best to have the patient wear the lenses only for the distance and lay them aside in close work unless he holds objects too close, necessitating too much strain on the muscles of convergence. In quite young persons it is better, if possible, to have the patients wear the lenses constantly in order to develop the accommodation. In myopia over 2.00 D. or 3.00 D. the use of bifocals is often advisable, great care being taken not to add too strong a segment. Space forbids a full discussion of anisometropia; but in cases in which a patient does not enjoy binocular vision or uses one eye for distant vision, the other for near, attempts to equalize them or adapt both to one distance will be fruitless and contrary to the best interests of the patient.

The far and near point giving a fair idea of the amplitude of accommodation should be found. In testing for close work, not only the best but also the nearest and farthest distances at which the print can be comfortably read with lenses should be determined. This gives the ordinary accommodative range. In difficult cases, especially in those who have previously complained of their lenses in close work, the accommodative range in each eye separately should be carefully ascertained. In testing the accommodation by means of test-types, the retinal image varies in size, depending on the distance of the test-type from the eyes. For accuracy this image should not vary in size and thus change the visual angle; therefore, ordinary tests with test-types or with lenses are inaccurate. I have found the punctumeter, a variety of Badal's optometer (Tscherning[3]) in which the retinal image remains the same size, convenient and sufficiently accurate, as by it the accommodation may be quickly measured. Last year before this Section Duane[2] described a disc and method for testing the accommodation.

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[1] Hess, Carl: Modern Views on the Physiology and Pathology of Accommodation, The Journal A. M. A., July 26, 1907, xlix, 230.

[2] Duane, Alexander: The Accommodation and Donders' Curve and the Need of Revising Our Ideas Regarding Them, The Journal A. M. A., June 19, 1909, lii, 1993.

All these tests should be made with the patient's back to the source of light, thus avoiding contraction of the pupils sufficient to affect the result. Any of these tests may be misleading if the muscles have been fatigued by a previous long examination, especially if by fogging or other methods the patient has been induced to relax wholly or partially his accommodation. On the other hand, such tests made in the beginning of the examination, during or after it, when a spasmodic effort is made by the strained eyes of the anxious patient, may demonstrate greater accommodation than is ordinarily present. Accommodation in some people, especially in neurasthenics, in certain hysterical persons and in those with marked convergence defects, is very variable, the ciliary muscles easily becoming exhausted, so that it is instructive to make these tests early in the examination as well as after the eyes are tired. This exhaustion of the accommodative apparatus partially explains the blurring and other difficulties certain persons experience after continued close work which they do not notice in using the eyes for a short time. When the blurring begins they bring their close work nearer, securing magnification, sacrificing clearness but forcing additional work on their already exhausted ciliary and adducting muscles.

By the tests described above the amplitude of accommodation on the two sides may be shown to be quite unlike, the result of various diseases, especially those of the nervous system, usually weakening, paresis or paralysis of accommodation and possibly, in rare instances, spasm of accommodation. For close work it is occasionally necessary to place a stronger lens before the eye with the weaker accommodation. Commonly the differ-

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3. Tscherning: Physiologic Optics, pp. 83 and 84.

ence between the lenses will be from one-third to two-thirds the difference of accommodation, or in young persons even less than one-third (Jackson[4]). It is very helpful to know that there is no accommodative power in some old people with not very clear media and small pupils. The vision may be so blurred that they cannot select the proper amount to add to their distance correction for near work, e. g., such a patient may not be able to chose between a +2.00 D.S. or +3.00 D.S. added to the distant correction. In these cases the equivalent in diopters should be added, as for 33 cm. a +3.00 D.S. should be added to the distant correction. While the range of vision with lenses for close work should be found in order to help determine the best lens, as too strong lenses often limit the range too much, and while the amplitude of accommodation should be determined and will prove helpful, rules for prescribing applicable to every case cannot be made. Probably no one could constantly employ his full accommodative power, but it is impossible to say whether a particular patient can use two-thirds or one-half of his power, as asserted by some writers. Some persons can use three-fourths of their accommodative power more constantly and easily than others can one-fourth. Fixed rules, a given distance or method are not applicable to all cases.

After having determined the ametropia for the distance, and, in special cases, the amplitude of accommodation, the distance which the patient prefers for close work should be ascertained. Next he should be placed with back to source of light and a test chart given to him. He should not be permitted to face the source of light, as this causes contraction of the pupils, partly preventing diffusion circles, thus doing away with the necessity for lenses and making it difficult or impossible to find the correct strength for ordinary conditions. The test-card should not be in direct sunlight, although it should be in good daylight without the patient's shadow on the card. Good artificial light from a source behind the patient serves well, and, as this is the kind of light commonly complained of, its use is often advantageous. He should be directed to look at test-letters of about the size of ordinary print, e. g., .75 D. or Jaeger 4. If the patient's vision is poor he should be directed to look at

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4. Jackson: Ann. Ophth., July, 1907.

larger letters. If the test is made with very small letters the patient is likely to hold such letters a little closer than he would ordinary-sized letters, sacrificing ease and clearness to secure greater magnification. A sheet of ordinary music should be used when lenses are desired for reading music. If care is taken that the lenses are properly centered in the trial frame a seamstress may suggest something helpful as to distance if required to thread a needle and possibly to make a few stitches.

The range for the test-object should next be found; first, how far away the letters can be comfortably seen; next how close they can be easily read, and last the best distance at which they can be seen. The patient should be told to confine his attention to the distance for the lenses being tried, for if this distance is unsatisfactory it may be made right by other lenses and that, therefore, he should totally put aside his preconceived ideas of the proper distance for his work.

Persons in various vocations prefer different distances. A bookkeeper, type-setter, laundress, painter, carpenter, pianist, violinist or one who works at a flat-top desk rarely likes lenses which necessitate his coming close to his work, e. g., by leaning forward over books or desk. The lenses for the ordinary reading distance should first be found which will greatly aid in determining the proper lenses for particular distances. We have described our ideas about the proper distance for close work, especially as dictated by heterophoria and convergence tests, and the necessity for muscle exercises and prisms in these conditions in former papers.[5] These papers emphasized the point that, whenever lenses are prescribed, the intimate relation between accommodation and convergence is changed, requiring readjustment; further, that a patient with a strong desire for fusion, or single vision, may have marked ability to converge for a short time, or, for that matter, to rotate the eyes in any direction, just as a hypermetrope can accommodate, but that he is likely to become tired by such forced convergence, just as a hypermetrope becomes tired by forced accommodation, if the eyes must, in order to secure single vision, be rotated considerably from what may be termed their position of rest for any particular distance.

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[5] Stevenson, M. D.: Ophth. Rec., July, 1904, and February, 1907; Practical Importance of Hyperphoria in Prescribing Lenses for Use at Particular Distances and in Different Directions, THE JOURNAL A. M. A., July 17, 1909, liii, 203.

The examiner, in order to prevent early change of lenses and to thus lessen the patient's future expense, is often tempted to prescribe too strong lenses for close work. These limit the patient's range for near work, and, while lessening the accommodative stimulation to convergence, add to the convergence strain. For ordinary patients with good convergence power, for reading and sewing it is usually well to prescribe lenses for about 37 cm. This is a little too close for sewing on a machine or ironing, but is a good average distance. This distance is varied, depending on the vocation, desires of the individual patient, conditions of the extraocular muscles and convergence power and also dependent on whether there is binocular single vision. Unless the vocation demands otherwise, a one-eyed patient will usually prefer a strong lens if convex, and those with marked subnormal vision will also usually accept a strong lens, preferring magnification to clearness, range, etc.

As in tests for the amplitude of accommodation, it is sometimes necessary to make separate and repeated tests for the best lens for close work, since the ciliary muscle, if exhausted by the previous examination, will require too strong a lens for ordinary use; that is, a lens which at the time of examination gives a reading distance of 37 cm. may in the ordinary condition of the eyes have a reading distance of considerably less. On the other hand, there might be a spasm of the ciliary muscle, and on continued use the lens would be too weak.

Accommodation is strongest in the young, not in infants, and gradually diminishes afterward until abolished. The age when special assistance to the eyes in close work because of weakened accommodation is first required varies, but much depends on the general health and vitality, the vocation of the patient, the amount and nature of ametropia or heterophoria present and the size of the pupils. Accommodation is the first important function to weaken and does so while the ordinary muscles of the body are growing and developing, possibly suggesting its biologically difficult and recent acquirement, especially as it is imperfectly developed in the savage and in the lower animals. In these times of overworked eyes, as in reading, embroidering, engraving, etc., special help for the accommodation is frequently demanded, i. e., a stronger lens if convex, weaker if concave, than the proper distance correction is required.

Many patients over 30 or 35 complain of the use of their eyes only in close work. They are usually given their full or nearly full distant correction, to wear constantly. Many of these with a low degree of ametropia, especially with only a little astigmatism, with good extraocular muscles, will get greater relief and avoid the nuisance of wearing lenses constantly if a somewhat stronger convex or weaker concave lens than is required for the distance is prescribed for close work only.

Judgment and great care must be exercised in these cases. If there is much astigmatism or if a prism, especially a vertical prism, is required it may be better to prescribe only the full correction and as accommodation diminishes and this correction fails to satisfy in close work add a segment or give a separate stronger pair of lenses for near. A + .50 D. or + .75 D. segment added to the distant lenses often greatly aids the patient. It should not be forgotten that even if the ametropia for the distance is fully corrected in close work the ciliary muscle is compelled to make continuous effort, for instance, 3.00 D. at 33.3 cm. The time is probably coming when many more young people than at present will wear bifocal lenses, giving clear and easy vision at the distance and special aid in near work.

When patients past middle life complain only in doing close work and the eyes are normal or nearly so for the distance, lenses may be prescribed only for the former. In these cases, however, bifocals should often be prescribed, the patient being requested to wear them only for close work. Even a weak lens correcting the ametropia is preferable to a plane lens, and if a large segment with its upper edge just below the lower margin of the pupil is given in frames with good reading angle the patient will find it more convenient in doing his close work, not having to remove his lenses to see at the distance. The main objection to bifocals, viz., that the patient cannot see easily when walking about is removed, as the lenses are used only for close work. For patients who object to this use of a bifocal or for those whose vocation demands a whole lens, e. g., certain dentists or bookkeepers, a single lens is prescribed. Some prefer to use half or clerical-shaped lenses.

When there are symptoms of asthenopia, e. g., headaches, blepharitis, etc., due to a considerable degree of ametropia, two pairs or bifocals should be prescribed. Two pairs are better for those engaged in certain vocations, whose eyes must be directed through every part of the lens, as for dentists, bookkeepers, type-setters, sign-painters, etc., but they are inconvenient in many well-known ways. Two pairs require more care and must be frequently changed, especially difficult as it necessitates the use of both hands, a case, and some place to lay one pair of lenses.

To avoid the use of two pairs several substitutes have been used. Grab-fronts, whole or half lenses, grab-backs, whole or half lenses, are very serviceable in some cases. Half grab-backs serve like a bifocal both near and distant vision, but for those who wish a whole lens and desire to make quick changes the whole grab-back is useful. The grab-backs are not convenient for those who are often required to look upward, as salesmen in stores, painters or carpenters, for the grab-back then slips backward against the eyes; or for those who, like skirt-fitters, are often required to stoop. since the lenses are then liable to drop out from behind the spectacle frames. Grab-fronts hang on better than grab-backs, but are more difficult to adjust; and both are objectionable because of appearance, can be used only with spectacles, require careful and frequent adjustment and the rubbing together of the lenses scratches and mars their surfaces.

The most generally used substitute for two pairs is the bifocal, and, while the patient is usually disappointed in their use during the first few weeks, he usually likes them after becoming accustomed to the necessary blur of distant objects seen through the lower portion of the lens in looking downward and to the doubling of objects seen through the upper margin of the segment. The difficulty with this upper margin is much less in kryptoks and so-called invisible bifocals than in the older varieties. The patient should be given to understand that at first he must be patient with bifocals. In many ways they approach the ideal for two distances without any change of lenses. The segments are easily and cheaply changed. They may be prescribed either in spectacle or nose glass frames and with any degree of durability and elegance. For temporary use a detachable segment suggested by H. G. Huffman of Youngstown, in which the segments may be quickly clamped on the distant lenses by merely pressing them into a special case, may be employed. This form of bifocal may also prove useful in making a prolonged trial of double lenses. They are superior to other bifocals in that the patient may discard them when not doing close work, may have two pairs of them for different distances, may place one pair over regular bifocals and in that they can be easily decentered.

With bifocals the great difficulty complained of is in seeing downward at a distance—seeing the sidewalk, curb, etc., when walking. We formerly made the common error of trying partly to avoid this trouble by prescribing too small segments, by giving frames so that the segments were placed too far below the pupils. It did help the patient when walking about, but made near work more difficult and tiresome. The very small sizes require too much adjustment of objects looked at, give too small a field. Very large segments are required only for those who must move their eyes much in their work. They can scarcely be made large enough for bookkeepers and some dentists. Small segments for distant vision may be placed on the uppermost portion of the lens, the remaining large part being for close work. If the segment is placed too low the eye is compelled to look downward to such a degree as to tire the external ocular muscles. A false lens astigmatism is produced by looking through the strong segments at such an angle; also the effect of a stronger sphere results so that the patient is compelled to hold his work closer than was intended by the prescriber. This tires the eyes because of the increased amount of convergence required. Experience has taught us that the segment should be only very slightly below the pupil, especially in those who wear the bifocal only in close work, and that all lenses for near work, especially bifocals, should have the top tilted considerably farther away from the face than the bottom—a large reading angle.

Toric lenses give a better reading angle in the segment than ordinary lenses. With a good reading angle the eyes then look more directly through the lenses with less false lens astigmatism and with more nearly the spherical effect desired. Ordinarily the patient will soon accustom himself to walk about with segments high up. If spectacles are worn, for a time the frames can be pulled forward and down on the nose while the patient is walking. With nose-glasses, in close work, the reading angle should often be increased by tilting outward the top of the lenses. When a different prism is required in the reading lens from that in the distant lens it can be made in bifocals, but is often better employed in two pair. Last year before this Section one of us described a method by which hyperphoria in various planes for near work can be examined, and pointed out that, since it sometimes varies in different planes, it is necessary to prescribe different prisms for near than for the distance, also that such patients as well as anisometropic patients must learn how best to hold the head and eyes, that for such there is only one best position or plane in which the object should be held.

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MEMORANDA

THE PREVENTION OF BLINDNESS*

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There has never been a time when, as now, the world has given such careful thought and scientific study to the causes of disease and the most effective measures for its prevention. Within the last decade public health has assumed a new importance. As medical knowledge has become more exact, the needlessness and the costliness of disease have become more evident and the public has joined forces with the advance guard of the medical profession in the development of what is practically a new science—preventive medicine.

In the evolution of this work, certain facts have taken on new relationships and have stood out in greater prominence than ever before. We have come to realize that the social fabric of our modern life is woven together by the forces that make for the physical well-being of the people. We now know that disease is neither an accident nor a mysterious incident in a vast number of cases, but that it is the logical resultant of conditions which have preceded it, and an essential factor in maladjustments which must follow it. If, then, we so govern existent conditions that the level of human efficiency may be raised, or at least so interpose that conditions may not obtain whereby it shall be lowered, we thereby advance all human progress to a degree which we can never estimate. The inspiration, for example, that has come from the study of so universal a malady as tuberculosis has led its investigators far afield in inquiries concerning collateral relationships, social conditions and remote results. It is found to be a resultant of poverty and related to crime, and wider knowledge concerning the conditions under which it develops has modified the lives of thousands who may never have been threatened by it.

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In like manner, a study of destructive diseases of the eye, or even those impairing its usefulness, will be found to have economic and social bearings as well as those of a strictly medical character.

Ophthalmology has been among the later of the branches of medicine to institute any broad inquiries in relation to preventive medicine—perhaps because, while ophthalmology is one of the more distinctive departments of medicine it is at the same time one of the most technical, and, by common consent, diseases of the eye are supposed to be relegated, both by the lay public and by the general practitioner, to those whose studies and experience peculiarly fit them for this work.

If it can be shown, then, that blindness to any large extent exists which under more favorable conditions should have been avoided, it manifestly becomes the duty of ophthalmologists to initiate such measures as may be necessary for the public safety, because others neither know that eyes are lost which should be saved, nor are they informed as to what should be done to prevent such disasters.

Recognizing these important points, it is the purpose of this paper, not to suggest detailed measures for the prevention of blindness, but rather to emphasize the fact that a problem exists and that, as yet, no public movement has been organized for the purpose of solving it. The whole subject is new and as yet is merely in its inception; but with the cooperation of the ophthalmologists of the United States it gives promise of limiting human suffering and increasing human happiness to an immeasurably greater degree than could be obtained by our combined efforts as physicians and surgeons, directed to the relief of conditions which have already obtained; just as the prevention of disease is always and from every standpoint better than is its most successful cure.

When we speak of blindness, moreover, it should be borne in mind that the preventive measures which may be suggested are equally applicable in a vast number of cases in which total loss of sight has not occurred, but in which one or both of the eyes have suffered damage to such a degree as to lower the visual efficiency, and these are as the sands on the seashore. The lack of definite official action on this medico-social subject is shown at the very beginning in the absence of any authoritative definition as to the meaning of blindness.

The instructions given to the enumerators of the Bureau of the Census for securing data for the twelfth census of the United States, that for the year 1900, required the enumerator to ask "whether all persons enumerated have good sight and good hearing, i. e., can see and hear well." "And should it appear that the sight is so seriously impaired that it is impossible for the person to read a book, even with the aid of glasses," the enumerator was directed to note such person as "blind," even though he or she may have some slight power of sight. In most schools for the blind, a candidate for admission is considered blind who does not possess sufficient sight to be educated in schools for the seeing.

The Massachusetts Bureau of Statistics of Labor provided the following definition of blindness for the guidance of enumerators in taking the decennial census, and this was also adopted by the New York State Commission for the Blind in 1906. It included persons who "with the aid of glasses are yet unable to distinguish form or color, to count the fingers on the hand at a distance of one foot, or to read writing or ordinary print."

It would at once be evident that all these definitions lack exactitude because of the elasticity of the term blindness itself. The fairest and most just and discriminating definition of blindness is that of Dr. Lewis Stricker, given in the article read before the Ohio State Medical Association on blindness in Hamilton County.

He proposes a standard defining blindness of three degrees. The first is total or absolute blindness in which the light sense is completely abolished. The second, which might be termed relative blindness, is that in which the vision with either eye, with proper corrective glasses adjusted, is so low that fingers can no longer be counted at one meter or three feet, but movements of the hand or moving objects may still be discerned. The third, practical blindness, is that in which moving objects may still be discerned at three meters, or nine feet, but in which the field of vision has become so impaired (either by contraction of the field down to five degrees or less, or in which central vision is entirely abolished and a small area of excentric vision remains, or in which disseminated scotomata exist, or in which is found only a sector of excentric vision) that no useful vision remains and the individual gets about with great difficulty. Fourth, only those are to be considered as blind who are hopelessly and incurably so. As a basis for any statistical data that may be secured, it would seem necessary that this or some other equally precise definition should be officially adopted so that all records taken may have at least a relative degree of precision.

INACCURACY OF THE FEDERAL AND STATE CENSUS REPORTS

The absence of any accurate definition of blindness has been followed as a natural consequence by the greatest inaccuracy as to its extent as indicated by our national and state census reports.

Many individuals with uncomplicated cataracts have been placed among the ranks of the blind, to be practically but not technically taken from this list after the eye or eyes had been successfully operated on. Many persons were recorded as blind who had one defective eye or who had had one eye removed. The enumerators who took the census for the New York State Commission for the Blind found that many persons had been recorded as blind who were not blind at all, having some weakness of the eyes simply, while others back in the country from the trunk railroad lines who were actually blind were, in many instances, entirely overlooked.

It is evident that for scientific purposes the only records that are of any value are those which are made by trained and experienced ophthalmologists, but these are conspicuous by their absence where we would reasonably expect to find them.

ABSENCE OF ACCURATE DATA CONCERNING BLINDNESS

The lack of accurate study on this subject is evinced in the almost total absence of any large amount of reliable data andin the inexactness of those which are obtainable.

There are four sources to which we might look for statistics concerning the relative incidence of blindness and the causes which produce it: the federal and state census reports, the records of public institutions having ophthalmologic departments or being devoted to the diseases of the eye, the reports of ophthalmic examiners of schools for the blind, and the private records of ophthalmologists.

The records of most of our public institutions as a basis for the study of statistical data concerning the amount of blindness which exists seem to be absolutely worthless. The annual reports of ten of the largest institutions in the United States for the treatment of diseases of the eye were carefully examined and none of them appear to contain other than the most superficial notes on the character of the cases presented. It is of very little value to the public or to any one else to know that there were so many cases treated involving this or that tissue of the eye and that the cost of maintaining the institution was so much. Yet in none of them, except possibly the Eye, Ear, Nose and Throat Hospital of New Orleans, was anything more than this attempted.

The possibility of utilizing the vast amount of material which passes annually under the observation of the skilled men connected with these various institutions seems to be neglected. A careful study of each case, or group of cases, with the method of treatment employed, together with the average number of days which the patients were under treatment and the final results obtained would be of great value and would add but little to the clerical labor involved.

For example, it interests no one to any large extent to know that three hundred and fifty cataracts were extracted at an institution during the year. But when the operation in a certain proportion of these cases has failed to give good results it interests every student of ophthalmology to know why. It is important to all of us to know whether higher visual acuity with greater or less corneal astigmatism is obtained by a section made in one way or in another, and when blindness results it adds a scientific value to the record if it is shown what conditions supervened to produce this disaster.

When an iridectomy or sclerotomy is made for glaucoma we should all like to know what the vision was before the operation and what it was six months or a year later. When vision for any reason has been reduced, while the patient was under treatment for corneal ulcer or other cause, it is a matter of definite value to know how long the patient was under treatment, what medical measures were employed and exactly what results followed.

If such records were made in all public institutions, two beneficial results would follow: First, the aggregation of a number of facts from which definite, helpful conclusions might be drawn as to the relative value of different methods of treatment. Second, the greater care which we would all use if we knew that our work was open to public criticism.

A third available source of study as to the causes of blindness should be our schools and institutions for the blind, but, except in very few cases, the causes of blindness are so unscientifically given as to make the record of doubtful value.

In several important schools for the blind no ophthalmic examiner is employed and no records whatever are made as to the causes of blindness. In a statement from one of the most important schools in the United States I read among the causes of blindness, in one case "meningitis," which probably means "optic atrophy," but it does not say so. The next is exophthalmic goiter, without any statement as to the condition of the eyes producing blindness. A third is "accident," another "disease of the blood," but this is starred as not the oculist's statement, which by inference would mean that the others were. Still another is "glaucoma," which is said to have occurred "in a child of 2 years of age," another "measles," another "congenital," simply, still another is "consanguinity," with an interrogation point, whatever that may mean. "Neuritis, whooping cough, uremia," etc., are also other assigned causes. Certainly none of these were obtained as the result of an accurate physical examination made by a competent examiner, and, for scientific purposes, they have practically no value whatever.

In some cases, however, the most exact and detailed pathologic statements are given and the record obtained is of corresponding value.

There should no doubt be a uniform record blank in every institution for the blind, on which the condition of each eye should be accurately specified, the age at which blindness occurred and the cause, so far as can be ascertained, on which the loss of sight was dependent. If this were carefully noted in all institutions, it would add another source of exact and practical, available knowledge.

But the most useful and easily accessible source of data of this character would be our own daily records. It would be a simple matter if each man had on his desk a printed blank on which an exact record could be made, taken from his case book, of the age and sex of the patient, the eye involved, the degree of blindness and, when ascertainable, the cause of the loss of sight. On this could be briefly included those cases presenting during the morning's work which came under the accepted definition of blindness, with an opinion as to whether or not it might have been prevented.

It is astonishing how relatively frequent are the cases in which but one eye is blind. But they probably would not number more than a dozen during the course of the week, and the accumulated observations made by a number of carefully trained men, while taking but a minimum of effort, would when aggregated give exceedingly valuable results. Such data must be secured before we shall have any absolutely dependable basis on which to establish our future work in prevention.

THE VALUE OF SOCIAL SERVICE

The prevention of blindness from the medical viewpoint may be interpreted in any terms which make for better care of the eyes. Most of our clinics are too large for the limited time in which a long line of people must be seen, and there is very little left for the consideration of the individual. We lose the human element, and this frequently is the key of the whole situation.

Here the great value of social service supplemental to and in harmony with the medical or surgical work is especially evident. In my service in the Charity Eye, Ear and Throat Hospital of Erie County, a poor woman with several children presented hereself with corneal ulcer. Before applying the conventional treatment the woman's appearance constrained me to ask if she had enough to eat. She reluctantly admitted that she was starving. A note to the Charity Organization Society verified her story, but developed the additional fact that a well-to-do relation would gladly aid her when he learned of her condition. It was necessary only to bring the two together. Treatment under such conditions would have been mockery until her immediate necessities had been supplied, and without proper nutrition a cure would have been impossible.

On another occasion a 16-year-old girl appeared with functional amblyopia in one eye. She had been visiting the clinic for some weeks before her home conditions were investigated. This poor child was found living alone with a decrepit, insane mother. When the mother had been put in a hospital for the insane and the child placed under proper influences, the hysteria which was possibly prodromal to more serious nervous disturbances spontaneously disappeared. The home surroundings, the social life, the conditions under which the eyes are used are frequently such as to make successful treatment of serious trouble impossible. Diseases of the eyes due to malnutrition from improper feeding are more commonly the result of ignorance than of poverty, and helpful advice as to the adoption of better methods is usually not only welcomed, but gladly followed.

It is often impossible for the physician, even if he had the time, to get behind the barrier of timidity and apprehension within which the poor patient is barricaded; and yet such knowledge is often essential to effect relief which can be obtained only by the intelligent and sympathetic intervention of the social visitor, who by supplementing and explaining the advice of the surgeon of the urgent necessity of an iridectomy for glaucoma or an enucleation for sympathetic ophthalmia may save eyes that through neglect would otherwise be lost. By the adoption of such measures as these the frequency of visits on the part of the patient to the clinic will be greatly reduced and time will be allowed for other and more scientifically profitable cases.

PREVENTABLE INDUSTRIAL ACCIDENTS

Another cause of unnecessary blindness is found in the preventable industrial accidents. Johnston,[1] in an admirable article on this subject, divides these injuries into four classes:

1. Those occurring as the result of handling high explosives in mining and railroad construction.
2. Those occurring from the bursting of locomotive oil and water gauges.
3. Those occurring in mills, foundries, machine shops and the building trades.
4. Those occurring in the agricultural pursuits.

In precaution he advocates: (1) Government inspection of manufacture of all explosives; (2) licensing of "foundermen"; (3) protection of water and oil gauges by wire or plateglass screens; (4) the placing of guards on all emery wheels, lathes, etc.; (5) education of the laity as to the seriousness of even slight injuries when infected.

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[1] Ophthalmology, July, 1909.

To this may be added, as Ayers of Cincinnati has shown, the danger of poor tools, which readily chip and which constitute another prevalent source of unnecessary injuries. The obligatory use of properly tempered steel hammers would materially limit the number of accidents of this character.

THE PREVENTION OF HEREDITARY BLINDNESS

Just how far it is practicable or possible for the state to exercise control in eugenics is still a moot question, but as to the urgent necessity of employing every moral agency in preventing the marriage of those whose progeny is sure to be defective there can be no question whatever.

In the New York State School for the Blind is a child who represents the fourth generation of blind individuals. These, with a collateral branch, number eighteen people who have inherited blindness from a great-grandmother, and most of these have been charges on the state. The least unhappy result of this unfortunate inheritance has been the cost to the state of thousands of dollars. The real tragedy is the bringing into the world of a race of weak-minded degenerates, whose propagation may be continued endlessly.

This is a public calamity. It is a duty resting on all of us that measures be taken whereby this frightful state of affairs be brought to an end. It would be economy and wisdom on the part of the state to make some provision for the permanent institutional care of such unfortunates, separating the sexes and preventing in every way possible the further increase of their kind. This is, indeed, but one phase of a large subject, but it is one demanding consideration and some form of effective action.

BETTER TRAINING NEEDED IN OPHTHALMOLOGY

It is an unfortunate fact, but one which must be admitted, that many eyes are lost through the inadequate training of those who assume to treat them. Many operations result badly, either because they were ill-advised or clumsily performed. For this we are ourselves largely to blame. We have no standard by which may be determined the qualifications of a physician who undertakes such expert and delicate work and work requiring such precise and technical knowledge as ophthalmology.

Recent graduates, after a few months of desultory observation in a large clinic and with inadequate preliminary training in physics, pathology or surgery, with the audacity of ignorance, attempt the most difficult operations on the eye, thereby verifying the classic though monstrous dictum of Baer, that "it takes a hatful of eyes to educate an oculist."

Modern aseptic methods have made the domain of surgery so tempting that it is not alone on the eye that operative sins are committed. Our most capable surgeons everywhere are recognizing the great dangers that are resulting from the bad work of unqualified men. It is a grave question whether the time has not come when our profession should consider the desirability of providing special degrees in surgery and ophthalmology, as has for so many years been done in Great Britain. An adequate curriculum and scholastic teaching, with a final degree in ophthalmology, given only to those of proved ability, as is now done at Oxford, were they provided in our great medical centers, where clinical material is so abundant and where the ablest teachers are to be found, would make it unnecessary for the ambitious student to cross the ocean in order to secure the best instruction in ophthalmology.

It is not the purpose of this paper to consider in detail the various preventable conditions which result in blindness, and no attempt has been made to deal with causes which would occur immediately to all who are familiar with the subject. Nothing has been said of Independence Day accidents, blindness due to wood alcohol and other toxic substances, of ophthalmia neonatorum and other forms of infectious diseases of the eyes, because all these have been more or less generally considered and it remains only to devise methods by which prevention may be made generally effective. But from these causes of diseases vitally important subject, which has not received adequate attention is the protection of the eyes of school children by securing for them suitably lighted and ventilated study rooms and properly printed books. It is in the school room that the foundation is laid in a large number of cases for the development of diseases which result in limitation of vision, if not in actual blindness.

It would seem that much might be accomplished by having a special committee from this Section representing the American Medical Association to consider all these subjects, to confer, if deemed wise, with a like committee chosen by the National Educational Association, so that these two great bodies, with possibly the cooperation of the various boards of public health, might together work out a solution of these problems for each of the states.

While many architects are familiar with proper forms of school construction and members of the association have worked out problems in lighting of rooms, relative size and character of lights, etc., there are no uniform regulations concerning the adoption of fundamental principles of hygiene and buildings continue to be erected and school books continue to be published so glaringly out of harmony with scientific methods that they ought not to be tolerated in progressive communities. Organized effort on the part of the medical profession for the purpose of obtaining better protection of the eye, if in conjunction with intelligent and discriminating social work, would do much in limiting the disasters which are due to controllable causes.

There is no more splendid work in which we could engage than in preventing conditions which our best skill is so often unable to mend. Such work would add dignity and importance to our branch of the profession by making it an essential element in the general preventive movement which is now everywhere occupying public attention. It is especially important just at present when those engaged in large philanthropic movements have given us the encouragement of their support. The directors of the Russell Sage Foundation in recognition of the practical and effective means which had been adopted in almost all of the states looking toward the prevention of ophthalmia neonatorum, felt that the time had come when a greater work for the prevention of blindness, due to other causes, might wisely be undertaken. Supplementing their former generous appropriations which provided an office and staff for the committee on the prevention of blindness of the New York Association for the Blind, and which has cooperated so effectively with the Committee on Ophthalmia Neonatorum of this association, a further appropriation was recently made, making possible the employment of a trained man who would be prepared to assist the medical and sanitary committees in the various states in carrying out a plan of work similar to that which has been so effectively inaugurated in Massachusetts, New York and Ohio.

To make this successful, however, the hearty approval and cordial support of the medical profession is imperative. With this the possibility of far-reaching and effective results through these combined agencies is so great that the movement which has been started bids fair to be second in importance only to that for the prevention of tuberculosis. It is earnestly to be desired that action may be taken by the Section on Ophthalmology at this meeting in support of this movement thus assuring those who are doing so much to advance this cause of the approval of and cooperation the members of the Association throughout the country in this important work.

454 Franklin Street.

MEMORANDA

MEMORANDA

TWO CASES OF CHOKED DISC DUE TO DISEASE OF THE ACCESSORY SINUSES OF THE NOSE *

C. A. THIGPEN, M.D.
MONTGOMERY, ALA.

CASE 1.—W. N., male, white, consulted me in the spring of 1909 for blindness in the left eye.

History.—The patient stated that two weeks previously he noticed blurring of his vision, when he at once consulted an ophthalmologist, who, after examining his eye, told him he had albuminuric retinitis and referred him to his physician who examined him thorughly and assured him this his kidneys were healthy and that he had no organic diseases of any kind.

Examination.—The patient seemed to be in robust health when first seen by me, and gave a clean health history, and but for his statement that his left eye was blind, no one would have suspected anything pathologic. Directing my attention to his eyes, I noticed the following: O. D. No departure from normal; vision, field, excursions, pupillary reaction to light and accommodation perfect. Ophthalmoscopic examination showed the nerve and retina healthy. O. S. No injection, superficial or deep. Anterior chamber not so deep as its fellow; pupil slightly dilated, and but feebly responsive to light. Tension; no increase. Vision; fingers at one foot with his back to the light. Ophthalmoscopic examination; choked disc, and retina edematous with a few small hemorrhages. Arteries small, veins large and tortuous. In view of the report of his physician that all of his organs were healthy, I was at a loss to know the cause of his eye trouble. To assure myself, another physical examination was made with the same result.

Nose and accessory sinuses. I next directed my attention to the nose and accessory sinuses and was gratified to find pus in the naso-pharynx, which, on later investigation, proved to come from the left side of the sphenoid. When questioned as to his nasal condition, patient stated that he had had a discharge from the post-nasal space for some years, but as it had never given any trouble save the discharge, he had regarded it with but little concern.

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* This paper has been accepted by the Executive Committee of the Section on Ophthalmology of the American Medical Association, to be presented at the St. Louis Session, June 7-10, 1910. Publication rights reserved by the American Medical Association.

Treatment.—He was told that his eye was seriously affected, with but little hope of recovery of vision and that the eye symptoms were probably secondary to the disease in the nose; he was also told that an operation might benefit him. He readily consented to this, and the operation was done in the usual manner, with the discovery of bone necrosis.

Subsequent History.—He experienced but little pain during the operation, and was sent to his hotel in excellent condition and remained so during the day. That evening, however, I was hurriedly summoned to him, and was much surprised to find the following condition: Pain in the left side of head and in and around eye, nausea and vomiting; the eyeball deeply injected, lower half of anterior chamber filled with blood, pupil widely dilated. T. + 2. Total loss of light perception. Morphia was administered, and the man sent to the hospital and placed in care of a nurse who was instructed to repeat the dose of morphia, if necessary, and to use locally, hot applications, which were continued through the night. The following morning brought no improvement. With temperature in the neighborhood of 101 F., and the patient bordering on collapse, in my opinion and that of my associates nothing short of enucleation seemed to promise any relief. This was done, and from that time the patient rapidly improved, and has since been in perfect health, his right eye being in every way normal.

This was a case of empyema of the sphenoid with bone necrosis and papilloedema, wherein operative interference served only to precipitate a serious intra-ocular hemorrhage with secondary glaucoma.

CASE 2.—F. Y., girl, aged 12, was referred to me in June, 1909.

History.—The patient stated that two weeks previously she had had a cold with considerable pain in the left side of the head, accompanied by discharge from the nose; at the same time she had fever. A few days before I saw her, the eyeball began to protrude and her sight to disappear.

Examination.—The patient presented the appearance of having suffered greatly, followed by some emaciation, and her general appearance was far from good. Temperature was 100 F. On inspection of eyes, O. D. presented nothing abnormal. O. S. There was considerable exophthalmos, the eyeball being pushed forward and outward; internal and upward movements were much restricted; pupil was moderately dilated and sluggish. T, normal. Vision, light perception.

Ophthalmoscopic Examination: The nerve head was much swollen with very indistinct margins; arteries were smaller than normal and veins were full and tortuous. On palpating around the eye, I discovered a fluctuating tumor in the nasal side of the orbit. My opinion was that the eye symptoms were secondary to accessory sinus disease, and an operation was advised, to which the patient readily consented.

Operation.—An incision was made over the fluctuating mass, which liberated about one ounce of very thick and offensive pus. On entering the cavity with a curette, a fistulous communication with the posterior ethmoid cells was at once discovered. With gentle curetting and pressure, a free communication was established with the left nostril, after which, gentle irrigation and packing with iodoform gauze was practiced.

Result.—The patient was sent to bed in excellent condition, and her recovery was uninterrupted. The exophthalmos gradually disappeared; the vision slowly returned, and while she was only able to read 20/200 at the end of a week, a later report from her physician assures me that her vision has been entirely restored.

13 South Perry Street.

MEMORANDA

THE PRESENT STATUS OF THE ETIOLOGY OF SQUINT *

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PHILADELPHIA

Twenty-five years ago, the theory of Donder's as to the causation of squint seemed firmly established despite the objections brought forward at that time by Schweigger, but since then several new theories have been advanced, one of which at least, has secured a considerable following. A study of the various monographs bringing forward theories other than the accommodative one shows that there is a lack of unanimity regarding the essential phenomena entering into the question. Thus one observer (Straub[1]) who believes that a failure of the development of binocular vision accounts for both the hyperopia and the squint, admits the almost constant and important association of the two conditions but has not found that the vision in the amblyopic eye can be improved frequently or materially by practice, and in those instances where parallelism of the visual axes is obtained he finds that only the rudiments of binocular vision have been secured.

Worth[2], the introducer of the theory of the failure of development of the so-called fusion faculty, does not find that there is an undue proportion of hyperopes of moderate degrees among squinters, but he does find that by practice the vision of the amblyopic eye may usually and greatly be improved and binocular vision established.

Bjerke[3] states his belief that a peculiar inervation is the cause of squint finds in the refractive error only a favoring influence and claims that the amblyopia is

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[1] Etiology of Anomalies of Refraction and the Origin of Emmetropia, Graefe's Arch., March 19, 1909, lxx, 1.

[2] Squint: Its Causes, Pathology and Treatment, Philadelphia.

[3] Graefe's Arch., Jan. 5, 1909, lxix, 3.

primarily a cerebral suppression and for a long time only functional, or we could not have the enormous improvement in vision which follows exercise of this eye. He also finds that binocular vision is so frequently recovered after operation for squint that it could not have been primarily undeveloped and thus the cause of the squint; and he says, further, that many can squint who have excellent binocular vision. The declination and hypertropia theory is brought forward by its sponsor (Stevens[4]) because he found these conditions almost constantly associated with squint and because he found no relation between hyperopia and convergent strabismus.

An analysis of the assertions contained in the above summary shows such contradictions in the findings and in the results of treatment that it would seem that they must result either from bias or from conclusions drawn from too few observations. One author finds constant association of hyperopia and convergent squint another finds no such association; one finds that the vision in the amblyopic eye cannot often or materially be improved, another finds that not only can vision be improved but that binocular vision can be established by practice; one finds that when binocular vision is secured it is only rudimentary while another finds it so frequently restored after operation that he is convinced that the center for binocular vision could not have been undeveloped.

According to its opponents, the inherent weakness in the accommodative theory is that it is not always high degree hyperopes who have a convergent squint and that all squinters are not hyperopic.

The fact that some clincians have not found a greater relative proportion of hyperopia and convergent squint than would be accounted for by actual greater frequency of this refractive condition of the eye, has caused these observers either to discard Donder's theory or to assign but a secondary importance to the refractive error.

Stevens, who believes the causes of convergent strabismus to be the declination of the meridians of the eye and hyperphoria (the latter usually itself the effect of the declination), gives the state of the refraction in 67 of his cases of esotropia. Of this number 23 individuals were emmetropes, 18 myopes and 20 hyperopes. The estimations were made without the use of cycloplegics.

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[4] Motor Apparatus of the Eye, Philadelphia.

He has observed that "in many cases in which during the period of life while accommodation was active, atropin revealed a supposed 'latent hypermetropia,' there has been no indication of hypermetropia when, as the result of presbyopia, years later, the accommodation has been practically abolished." He says that "it thus appears that the mydriatic may cause a condition of apparent hypermetropia, which is not the normal refractive condition of the eye."

He justly holds that the figures given above do not sustain the view that convergent strabismus is caused principally by hyperopia but then these figures are at variance with those of all other writers. I do not share in the opinion expressed by Stevens regarding the production of hyperopia by the use of a mydriatic. I have oftener seen a hyperopia develop or an existing hyperopia increase at the time of life when the accommodation is weakened by age. More rarely, a decided rapid increase in the refraction of the eye is seen as the result of swelling of the lens at this same period of life.

I have made a tabulation of 485 cases of convergent strabismus with hyperopia in groups according to the refractive error present in the meridian of lowest error of the fixing eye. This plan was followed in order that the results might be compared with the statistics of Worth which are similarly arranged. In my series, all the estimations were made under cycloplegia produced by a 1 per cent. solution of atropin instilled into the eyes three times daily for from 2 to 5 days. Reference to the table published by Worth will show that in 66 per cent. of his cases the hyperopia was over 3 D. In my series this group represented 44 per cent. of the whole. In 68 per cent. of Worth's cases the error was higher than 2 D. In mine in 70 per cent. Basing the calculation on the highest meridian of the deviating eye my series shows that in 55 per cent. the error was over 3 D, and in 75 per cent. it was over 2 D. It will be noted that in 10 per cent. the error was over 6 D.

Comparing the above percentages with those in a series of 250 cases of hyperopia without squint, grouped according to the refractive error in the highest meridian, in which the patient sought relief from asthenopia, it was found that in only 10 per cent. was the error over 3 D, and in 27 per cent. over 2 D, and in only 1.2 per cent. was the error above 6 D. There were no cases in which the hyperopia equalled 8 D. In

TABLE 1.—FOUR HUNDRED AND EIGHTY CASES OF MONOLATERAL CONVERGENT SQUINT ARRANGED IN GROUPS

Refractive error in the lowest meridian in the fixing eye.	No. of Cases.	Percentage Whole Numbers.		Refractive error in the highest meridian in the deviating eye.	No. of Cases.	Percentage Whole Numbers.
Not above + 1 D	48	10	56%	45%	33	7
Above + 1 D, not above + 2 D	98	20			86	18
Above + 2 D, not above + 3 D	126	26			96	20
Above + 3 D, not above + 4 D	90	19	44%	55%	102	21
Above + 4 D, not above + 5 D	55	11			76	16
Above + 5 D, not above + 6 D	36	8			43	9
Above + 6 D, not above + 7 D	20	4			31	6
Above + 7 D, not above + 8 D	5	1			12	3
Above + 8 D, not above + 9 D	3	0.6			3	0.6
Above + 9 D, not above + 10 D	...	..			3	0.6

a series of 500 cases in which the percentages are calculated on the error in the lowest meridian of either eye it was found that in less than 5 per cent. was the error above 3 D, and in 16 per cent. above 2 D, and in less than 0.5 per cent. was it above 5 D. In the above 2 series the estimations were made either under atropin or homatropin cycloplegia.

TABLE 2.—TWO HUNDRED AND FIFTY CASES OF HYPEROPIC REFRACTION ARRANGED ACCORDING TO THE REFRACTIVE ERROR IN THE HIGHEST MERIDIAN

	Number of Cases.	Percentage Whole Number.	
Not above 1 D	50	20	92%
Above 1 D, not above 2 D	137	54	
Above 2 D, not above 3 D	46	18	
Above 3 D, not above 4 D	11	4	
Above 4 D, not above 5 D	9	3	
Above 5 D, not above 6 D	4	1.6	
Above 6 D, not above 7 D	1	0.4	
Above 7 D, not above 8 D	2	0.8	

Some years ago I tabulated for Dr. William F. Norris 378 cases of convergent squint in reference to the state of the refraction. In 96.4 per cent. there was hyperopia in 1 per cent. there was anisometropia and in 2.9 per cent. there was myopia. A consideration of the above figures will show that not only is hyperopia the preponderating refractive error with other refractive states in a negligible quantity but that in considerable more than one-half of the cases, when the estimation is based on the highest meridian of the deviating eye, the hyperopia is above 3 D, and slightly less when it is based on the lowest meridian of the fixing eye. They also show that the high errors are of far more frequent occurrence than in non-squinting eyes, outnumbering them 10 to 1[5].

TABLE 3.—FIVE HUNDRED CASES OF HYPEROPIC REFRACTION ARRANGED IN GROUPS ACCORDING TO THE REFRACTIVE ERROR IN THE LOWEST MERIDIAN

	Number of Cases.	Percentage Whole Number.	
Not above 1 D	270	54	96%
Above 1 D, not above 2 D	150	30	
Above 2 D, not above 3 D	61	12	
Above 3 D, not above 4 D	9	2	
Above 4 D, not above 5 D	8	2	
Above 5 D, not above 6 D	1	0.2	
Above 6 D, not above 7 D	1	0.2	

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[5] In tabulating the cases which were obtained from the records of Dr. Norris, it was remarked that in the earlier years when less exact methods of determining the refractive error were in use the estimations gave a lower degree of hyperopia than in those obtained from more recent records and this probably accounts for the lower percentage of higher degrees of hyperopia in my series than in Worth's.

In the presence of a hyperopic error any condition which would reduce the vision of one eye below that of its fellow would act as an exciting factor in the production of a convergent stabismus, and this factor is frequently found in the existence of a higher degree of hyperopia or an astigmatism of a higher degree in one eye than in the other or in an unilateral astigmatism, as shown in the Table 4.

According to my figures, there is not the close correspondence between the number of hyperopes of over 2 D in squinting and non-squinting patients, found by some clinicians.

Worth admits that hyperopia stands in some close etiologic relation to convergent strabismus but considers that a defect of the so-called fusion faculty is the cause of the squint. If a defect in the fusion faculty be the cause why is this defect so largely associated with hyperopia of middle and high degrees and not oftener with hyperopia of low degree, emmetropia and non-progressive myopia? In my series, only 30 per cent. of patients had hyperopia of less than 2 D, whereas in hyperopia without squint this amount of error represented 72 per cent.

TABLE 4.—TABLE OF COMPARISON OF THE REFRACTIVE ERROR IN THE TWO EYES OF SQUINTERS

	Percentage.
Astigmatism greater in the deviating eye 0.50—1 D	17
Astigmatism greater in deviating eye over 1 D	25
Astigmatism greater in fixing eye	12
Hyperopia greater in deviating eye, 0.50—1 D	10
Hyperopia greater in deviating eye over 1 D	20
Hyperopia greater in fixing eye	2
No difference	10

A fusion faculty which had normally developed up to the time of the occurrence of a squint from disturbance of the normal relations between accommodation and convergence might lose its function when the need for such had disappeared with the loss of binocular vision. A similar loss of function is seen in the amblyopia of an eye which has been turned. In children convalescing from febrile disorders, and particularly from whooping cough, the power of accommodation is weakened and if the child returns to its books during this period a convergent strabismus sometimes results even though there may be present only a low or moderate hyperopic error. The weakening of the accommodation produces a disturbance of its relation to convergence precisely in the same manner as does a higher degree of hyperopia with a normal accommodative power, and a squint results even at an age when the fusion faculty is believed to be fully developed. The fact that cases of convergent strabismus have been cured by developing the fusion faculty after the method of Worth is taken as proof that a defect in this faculty must have been the cause of the squint. However, the method by which the cure of the squint is brought about consists of many steps and this renders it difficult to decide in what degree any or all are concerned in bringing about the result. The first step is the correction of the existing refractive error. The second is the overcoming of the amblyopia in the turned eye. The third is developing true fusion. The fourth is increasing the amplitude of fusion, during which procedure the angle of the tubes of the amblyoscope is altered in a way that aids in a restoration of the parallelism of the visual axes. The fifth is the further development of the fusion faculty by stimulating it to bring about binocular vision with the sense of perspective under equalized illumination of the objects.

Every clinician has observed how frequently the simple correction of the refraction error relieves the squint, and there is general agreement that Worth's ingenious method of restoring vision in the amblyopic eye is productive of excellent results; furthermore, in increasing the amplitude of fusion something is also accomplished in the way of diminishing convergence excess. So that aside from its purpose in developing the fusion faculty, the treatment must aid materially in restoring the normal relations between convergence and accommodation.

One of the cases reported by Worth is of particular interest. It was that of a child 5 months old with H.—5.5 D in one eye, and 6 D in the other. This child was cured by glasses and an occlusion bandage. Worth's explanation is that by giving glasses and so relieving strain on accommodation the visual axes were in the course of from 5 to 6 weeks brought back to parallelism and this allowed the natural development of the fusion sense to take place.

If it be as Worth says that the fusion faculty was allowed to develop naturally by reason of the visual axes having been brought back to parallelism it follows that if the visual axes had not been brought back to parallelism the fusion sense would not have developed naturally; and this, it seems to me, explains why the fusion faculty is found undeveloped in those cases of squint in which the refractive error has not been early corrected and in consequence of which a convergent squint has occurred. In other words, the undeveloped fusion faculty is a result and not the cause of the squint. The theory of the absence of a normally developed fusion faculty seems best adapted to explain essential alternating squint; that is, a squint which does not evolve into the monocular permanent type but which continues through life as an alternating one, as here, as a rule, the visual acuity and the refraction are not at fault. To me, it would seem that these facts, the absence of an error of refraction and the equal visual acuity of the two eyes, which sustain the theory when it is applied to this class of strabismus, rather weakens the theory when it is sought therewith to explain permanent monocular squint, as this form is so constantly associated with hyperopia and unequal vision (which determines the deviating eye that later becomes amblyopic). It would seem reasonable to suppose that the almost constant feature is the essential causative one.

The perfect correlation of the facts in myopia with divergent strabismus, with those in hyperopia with convergent starbismus, is a strong argument in support of Donder's theory. As the divergence does not occur early in life, but appears only after the developing myopia has produced a derangement of the normal relations which exist between convergence and accommodation, the fusion faculty is found to be well-developed. Notwithstanding this, it is powerless to maintain the parallelism of the visual axes when once the coordination between these faculties has been disturbed.

The theory of Donder's is upheld by the following facts: Convergent strabismus is associated with hyperopia in over 95 per cent. of the cases; the average degree of refractive error is very much higher in a series of cases of hyperopia with convergent stabismus than it is in a series of cases of hyperopia without squint; there is usually a difference in the refractive error in the two eyes sufficient to unequalize the visual acuity and thus favor a deviation of the more defective eye; in a considerable number of cases the correction of the refractive error relieves the squint (I believe that this number would be greatly increased if glasses were prescribed as early as the third year of life. Worth has shown that it is perfectly possible for them to be worn at an even earlier age); the fact pointed out by Donder that a convergent squint can be produced by placing before the eye a concave glass; that divergent strabismus is usually associated with myopia and that the same process of reasoning by which it is shown that hyperopia is the cause of convergent stabismus serves to explain the causation of divergent strabismus by myopia.

It appears to me that when one approaches the subject with an unbiased mind and considers the facts as they are, the accommodative theory accords best with these facts and when it fails in individual cases these can well be explained by other known causes of strabismus, such as congenital palsies, structural defects or anomalies, favoring effects of abnormal orbital axes, divergence weakness and congenital amblyopia. I believe, with some other authors, that congenital palsies of the ocular muscles are more common than heretofore supposed and that some of the cases of monocular permanent squint apparently comitant, with normal vision in the squinting eye, are the end results of paralytic strabismus.

I wish to express my thanks to Dr. J. Hiland Dewey and to Dr. D. Forest Harbridge for their kind assistance in the preparation of the statistics of this paper.

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MEMORANDA

CONCOMITANT SQUINT WITH SOME REMARKS ON ITS ETIOLOGY AND TREATMENT *

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The etiology of concomitant squint was but ill understood until Donders' masterly work on accommodation and refraction of the eye was published in 1864. Many fanciful theories and guesses were advanced to account for the "evil eye," as the Italians called it, some even attributing the affection to the agency of the evil one, as the name "evil eye" implies; while others gave such causes as sucking of fingers, looking at the tip of the nose, or at a curl at the side of the head, imitating the cross-eye of a companion, etc. Such etiologic factors as the above were advanced by the laity, who then, as now, were only too ready to give explanations of things not understood. It must be admitted, however, that the members of the "learned profession" were able to give but little better explanation as to the cause of squint; hence the professional advice as to treatment so often given; for example, to let the child alone to grow out of the squint.

In a survey of the literature of strabismus up to Donders' time one is struck perhaps more by the depth of ignorance than by the extent of knowledge shown in matters pertaining to the pathology of squint. Indeed, until Donders' day but one plausible theory resulting in a rational method of treatment of the deformity had been advanced—the muscle theory.

I. THE MUSCLE THEORY

This theory considered the cause of squint as a strictly local one and as a defect in the muscle itself. The squint was considered as but affecting but one eye. In convergent squint there was a shortening of the internal rectus muscle; in divergent squint a shortening of the external rectus muscle. The logical treatment, of course, was to cut the shortened muscle. Unfortunately the muscle was cut through the fleshy part and the good results expected did not follow the operation, the eye often squinting after the operation in the opposite direction to the previous one, and frequently to a greater extent. The muscle theory was faulty in two respects: first, in considering strabismus a local affection; second, in treating it as affecting but one eye; furthermore the refraction of the eye and the fusion sense were practically disregarded.

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II. ACCOMMODATION THEORY

In 1864 Donders advanced his well-known theory of hypermetropia as a cause of convergent squint, and myopia as a cause of insufficiency of the internal recti muscles and divergent squint, owing to a disturbance in the relation between accommodation and convergence. This theory may be stated briefly as follows: accommodation and convergence are intimately associated in the act of binocular single vision. For example, the emmetrope, in order to see well in the distance, exercises neither accommodation nor convergence, the eyes being in a state of rest, the rays of light properly focussed on the retina and the visual lines parallel. Such eyes, to see an object plainly at nearer distances, however, must exercise both accommodation and convergence. For instance, to see an object plainly at 1 meter, 1 D of accommodation must be used and at the same time 1 meter angle of convergence in each eye; to see an object at 0.5 meter, 2 D of accommodation and 2 meter angles of convergence must be used, the two functions increasing and decreasing in an equal ratio. In this way objects are seen distinctly and singly, the object being properly focussed, the visual lines being directed to the object looked at, whether it be in the distance or near; that is, up to the normal punctum proximum or the near point of binocular single vision.

In hypermetropia, on the other hand, the accommodation must act in excess of the convergence in order that the subject may see objects distinctly and singly, even in the distance; for example, with hypermetropia of 2 D the patient must exercise 2 D of accommodation to correct the static refraction of the eye to see well in the distance, while the convergence remains in a state of rest; that is, with the visual lines parallel. For such eyes to see an object distinctly and singly at 1 meter the patient exercises 3 D of accommodation (2 D to correct the static refraction and 1 D for the dynamic) while only 1 meter angle of convergence is used; for such eyes to see distinctly at 0.5 meter 4 D of accommodation must be used while only 2 meter angles of convergence are required.

Owing to the intimate association between accomodation and convergence this excess of accommodation over convergence has a tendency to increase the convergence of the eye more than is necessary—in other words, to cause a convergent squint. As a strong contributing cause to convergent squint in these cases, Donders, following Buffon, mentions an inequality in the refraction of the two eyes. Especially if there is astigmatism in one eye, or opacities in the cornea, in the lens or in the vitreous, or lesions of the fundus of the eye, in fact, anything tending to reduce the vision of the eye more than its fellow, convergent strabismus is liable to result. As other contributing causes Donders gave the widening of the angle alpha in cases of hypermetropia, paresis of accommodation, etc. As regards the angle alpha and its influence in the production of squint, in the last two years I have given the subject special attention. In hypermetropia of like amounts, I have found the angle alpha as great in the non-squinting patient as in the subjects who squinted; or the difference was so little in favor of the non-squinters so as not to be considerad. In myopia, however, the angle alpha was relatively considerably less in the eyes of the patients who squinted than in those who did not squint; and may have borne some relation to the squint.

Why it is that all hypermetropes have not convergent strabismus I shall discuss later and compare and contrast Donders' accommodation theory with the fusion theory of Worth.

III. FUSION THEORY

In 1893, Worth, in his book on squint, advanced the theory of a defect in the fusion faculty as the essential cause of squint (convergent). Worth states that the eyes are controlled at birth and a few months thereafter by the motor coordination alone, which serves to keep the eyes approximately straight in the absence of any disturbing influence. By the sixth month the fusion center begins to develop and by the end of the sixth year is fully developed. Worth says further that "when the fusion faculty is fairly well developed neither hypermetropia or anisometropia or heterophoria can cause squint. In fact, then nothing but an actual muscular paralysis can cause an eye to deviate."

In support of his theory Worth cites many cases of squint in which he was able to get the patient early enough, in both years and time of onset, by training the fusion faculty he prevented amblyopia and brought about a cure of squint. In contrast to this class of cases he cites the cases coming under observation late in years as to the onset of the squint, in which the vision in the squinting eye was practically lost and the fusion faculty but very poorly developed, or quite lost, and in which no amount of exclusion of the fixing eye and training of the fusion faculty could prevent or cure the squint. As still further evidence and support of his theory he reports the cases, in the family of a squinter, of younger brothers and sisters whom he had the opportunity to examine as to their fusion faculty. In all cases in which the fusion faculty was well developed (106 cases) not a single case of squint occurred, but in those cases with "doubtful" fusion sense (thirty-seven) six squinted later, while in fourteen cases with fusion faculty very deficient eight afterward squinted constantly, and one other occasionally.

As contributing causes of squint Worth gives first rank to hypermetropia, and fully recognizes the influence it exerts in causing squint, but mostly as a contributing cause. Other factors as contributing causes are mentioned, as anisometropia, congenital amblyopia, esophoria, specific fevers, violent mental disturbances, hereditary influences and, in divergent squint, exophoria.

Other contributing factors in the production of squint that may be mentioned are the following:

1. Faulty insertion and development of the muscles themselves.

2. Difference in length of the base-lines between the eyes, a narrow base-line making it easier for eyes to converge, whereas a broad base-line makes it more difficult (Manhart).

3. Increasing convergence relative to accommodation as the fixation point approaches; Landolt has called attention also to the fact that in hypermetropia the quota of convergence relative to the amount of accommodation increase more and more as the fixation point approaches, and that hence the hyperope may squint at first in near vision only but later for the distance also. In emmetropes this relation between convergence and accommodation is constant, while in myopia the quota of convergence diminishes relatively to that of accommodation under like circumstances.

4. Excessive development of the internal recti muscles. Donders states that in many cases of convergent squint the external fields of fixation are limited, but Worth denies this and in a great number of cases in which he examined the fields of fixation he found that in 81 per cent. of the eyes outward movement was perfect, and in the remaining 19 per cent. it was but slightly affected and only in cases of convergent squint of long standing, in which secondary changes and contraction had taken place in the internal recti.

5. Habit. Hansen-Grut has advanced the theory of habit as a cause of squint, as in some cases of convergence in moderate degrees of myopia. He explains it by an unconscious innervation of the internal recti which after a while produces a spasm of convergence and from the continued exercise of this the habit of convergence is formed.

6. Imitation of the squint in companions; as cause of convergent squint. (Parinaud).

There is a certain form of squint, also, which is termed neuropathic, in which the refraction plays but little part, and in which the eyes may either converge or diverge, and in which no satisfactory theory has been given as to the cause; the name "neuropathic," comes from the circumstance that in many cases of this squint the patient is exceedingly nervous or run-down.

7. Essential paralyses of divergence.

8. Spasm of convergence, likewise in convergent squint (Parinaud).

COMPARISON OF DONDERS' ACCOMMODATION THEORY WITH WORTH'S FUSION THEORY

It may be stated at the outset that neither theory accounts satisfactorily for all cases of concomitant squint (manifest and latent); in fact, both theories combined fail to solve the question in some cases, when some of the contributing factors as above enumerated may be called into play to account for it.

In passing it may be said that the muscle theory has been almost universally abandoned; hence I shall not refer to it further.

DONDERS' THEORY

That excessive action of the ciliary muscle can produce dynamic convergence even in the emmetropic eye was long since demonstrated by Donders. By placing a negative lens in front of one eye and screening the other, and having the patient look at a distant object, the hidden eye was shown to converge when the open eye looked through the negative glass, the tension of accommodation in the uncovered eye looking through the negative glass being manifest through an excessive action of convergence in the eye that was screened. Also in hypermetropia, which requires an excess of accomodation relative to the convergence, there is produced a tendency to convergence in such eyes. Especially is this tendency to converge liable to be manifested if one eye is more hypermetropic than the other and for any reason the visual acuity is reduced more than in the fellow eye, because in such instances the secondary image can be very easily suppressed and the eye converged without causing annoying diplopia. Not only may it be demonstrated that tension of the accommodation, even by a negative glass, in cases of emmetropia, may cause convergence, but we have it proved in clinical experience now and then. For instance in cases of anisometropia in which there is a high degree of myopia in one eye and hypermetropia in the other, the myopic eye converges at times, and this convergence may be entirely relieved by placing the proper correction on the hypermetropic eye. I have had this occur in two instances. Krusius[1] in a recent paper on divergent strabismus in hypermetropia and the effect of mydriasis on it strikingly showed the effect of changes in the accommodation in producing or relieving squint. In one case he found, on instilling atropin into the left eye, that the squint in the right eye was relieved, but again became manifest when correction of the hypermetropia in the left eye was made. He attributed the effect of the correction of the squint in the right eye by atropin in the left to a strong impulse in the left eye to overcome the hypermetropia, which was transferred to the right eye as an associated motor movement, thus correcting the squint. This seemed to be borne out by the fact that when the use of atropin was discontinued in the left eye and the ciliary muscle could act, the right eye again diverged. Another case along the same line is that reported by W. Wessenberg.[2]

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[1] Krusius: Arch. f. Augenkr., lx, 272.

A man of 25 showed voluntary inward rotation of the left eye while the other remained in the primary position; the right eye + 1 D., vision = 5/5. Left eye + 1.25 D., vision = 5/12. The voluntary squint was associated with accommodation of 4 to 5 D. and a — 4 D. was required for clear distinct vision of the right eye at such times, while squint did not take place in the right eye when it was used for reading, with + 4 D. glass.

It is often asked (and Worth dwells on this point) if hypermetropia causes squint why it is that not all hypermetropes squint? The reason is, as Donders pointed out, that, while the association between the accommodation and convergence is a close one, it is not a cast-iron fixed one. There is a certain latitude or amplitude, a dissociation, if you please, between the two; for example, a hypermetrope of 2 D can exercise 2 D of accommodation to correct static refraction when looking at a distant object and yet see it singly, though exercising no convergence whatsoever, or again when looking at an object 0.25 meter (10 inches) away can exercise 6 D of accommodation and only 4 meter angles of convergence, and yet see the object distinctly and singly. If this were not so, everyone, except emmetropes, would be doomed either to squint or to see indistinctly. The extent to which accommodation and convergence can dissociate themselves in cases of ametropia has its limits, however, and, sooner or later, the subject must choose either indistinct but single vision in both eyes or distinct vision in one eye and convergence or divergence of the other.

The fact that the average degree of hyermetropia furnishes the highest number of cases of squint is not surprising either, for, as explained by many observers, the striving for both distinct and single vision is greater in such cases than in the cases of very high degrees of hypermetropia in which no amount of striving serves to secure enough accommodation to maintain distinct vision, so that the effort is abandoned and hence follows no excess of convergence or squint. Worth and others deny this and Worth gives statistics and tables to prove that the degree of refractive error has very little to do with the question of whether the patient shall or shall not squint in the first instance. He admits, however, that when the squint is once established the refractive error becomes a very important factor. Worth further states that moderate degrees of hypermetropia are more common than high, which of course is well known, but the same thing obtains both in the squinter and non-squinters, and in fact is about the same; but he admits that most of the non-squinters who sought advice did so on account of headaches or visual defects. Why not admit, then, that those with moderate degrees of hypermetropia who did squint did so in order to escape headaches and indistinct vision by the act of squinting; that is, they sacrificed indistinct single binocular vision to comfortable clear vision with one eye? In fact, that is what really happens, as Donders asserts. We in America long ago realized the fact that patients with moderate degrees of error of refraction, especially when astigmatism is complicating, show more asthenopic symptoms than patients with very high degrees of error. The vast majority of hypermetropes who neither squint nor seek aid on account of asthenopic symptoms or faulty vision, have learned to associate their eyes in single binocular vision with comfort, though there is a disproportion in the accommodation and convergence. Another point often overlooked or forgotten is that, as Donders pointed out long ago, the amplitude of accommodation is greater for the same degree of convergence in hypermetropia than it is in emmetropia, and that this amplitude of accommodation is less in myopia than in emmetropia; and this again may account for some of these hypermetropes not squinting so readily, as the amplitude of accommodation comes in to save them from it. As Landolt[3] remarks:

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[2] Wessenberg, W.: Abstr. in Arch. f. Augenh. (Knapp's), 1908, p. 106.

> It would be putting a slight on Nature to assume that, incapable of creating only emmetropics, she had coupled accommodation and convergence in such a way that, instead of

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[3] Landolt: Refraction and Accommodation of the Eye, p. 199.

rendering the vision more perfect they would act only to disturb it. It may therefore be taken for granted, that in considering their intimate association the two functions must be independent of one another to a certain degree.

In turn, relative to the fusion theory of squint, it might be asked why every human being does not squint, soon after birth, if the straightness of the eyes depends on the fusion sense, since no fusion center then exists? Worth answers this question by stating that motor coordination powers of the ocular muscles serve to keep the eyes approximately straight until the fusion center begins to develop, and when this is fairly well-developed, he asserts, that nothing short of a paralysis can cause an eye to squint. Why may we not invoke the same agency, the motor coordination power, to account for the vast majority of hypermetropic eyes remaining straight?

In my opinion, for lack of a better explanation, we must give the inherent desire for single binocular vision in the human being as the stimulating force over the muscular coordinating powers, as a strong contributing factor in keeping the eyes parallel, certainly until the child is six months to one year of age, when there is no marked association between accommodation and convergence or any fusion center developed.

DIVERGENT SQUINT

As to the cause of divergent squint, invoking the accommodation and fusion theories to account for it, I shall give first Donders' own words on this subject:

> It is commonly the custom to apply the term squint exclusively to the absolute form. In this sense it is less frequent than strabismus convergence. And if, nevertheless, a certain number of cases, about equal to that in strabismus convergens, is to be explained by primary disturbance of the muscles (paralysis, inflammation, spasm, complicating congenital anomalies, etc., a blind eye also often deviates outward), myopia cannot occupy the same prominent position as an etiological element, that hypermetropia does in reference to strabismus convergens; nevertheless, in about two-thirds of the cases of *absolute* diverging strabismus, myopia was met with. But, if, on the other hand, we take relative diverging strabismus also into account, the diverging form is as frequent, if not more frequent than the converging; and now, moreover, the extraordinary causes, originally proceeding from the muscles or from blindness in one eye, fall into the background; therefore in at least 90 per cent. of the cases of *relative* diverging strabismus we find myopia.[4]

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[4] Donders: Accommodation and Refraction of the Eye, p. 400.

We see here that Donders takes into account not only the absolute (static) divergent cases which form a minority of the cases in myopia, but the relative (dynamic) cases of divergent squint, in which myopia is found in at least 90 per cent. of the cases. Furthermore, including the relative (dynamic) form of divergence with the absolute (static) form, they are more frequent than convergent squint. In myopia the accommodation is relaxed and indirectly the convergence is relaxed, and a tendency to divergence is established, dynamic or relative at first, but in the cases of progressive myopia this divergence often becomes absolute or static.

As is well recognized, other factors than that of accommodation enter into the eitology of divergent squint and Donders called attention to these; first, an original preponderance of the external recti muscles; second, smallness of the angle alpha; third the favorable form of the eye for outward movement.

Worth's fusion theory fails utterly to explain divergent strabismus, because divergent squint in myopia, as a rule, does not develop until between the seventh and twelfth years, when the fusion sense has been developed fully already. Hence the divergent squint develops in spite of and in the presence of a fully developed fusion center. Worth gives such cases as apparent exceptions to his rule. If we take into account, however, the relative cases of divergent squint, they are very numerous, as Donders long since pointed out. In fact, this is the weak point in Worth's theory of a defect of the fusion sense as the fundamental cause of squint.

ALTERNATING SQUINT

Although Donders did not attempt to account for alternating squint by the accommodation theory, this theory, in my opinion, may have some bearing on the squint, as will be shown later. Worth asserts that the fusion theory is the only one to explain these cases, and that in these cases there is a congenital absence of the fusion center. He states that the muscle theory can not explain it at all as there is no motor defect; and that hypermetropia can not cause it, as there is usually little refractive error.

I am aware of the fact that many of these cases have but little refractive error, the eyes being almost emmetropic or even, in some cases, myopic. The question, however, of what we call a little refractive error is a reative one. Worth[5] considers a hypermetropia of 1.75 D as insignificant, and a case in which glasses could be dispensed with. He also considers 0.5 D of astigmatism as normal. We, in America, correct much smaller errors of refraction than 1.75 D hypermetropia; also less than 0.50 D of astigmatism. It is significant, too, the number of cases of alternating squint that have hypermetropia in smaller or greater amount. In 229 cases reported by Worth himself, 196 had more than 1 D in the lowest meridan of one eye; and 176 of these 196 cases had 2 to 6 D, and the remaining 20 even higher degrees of hypermetropia up to 10 D. In looking over my casebooks I find the vast majority of these alternating squinters had hypermetropia and that the squint was almost without exception convergent. May it not be that, in a certain number of these cases at least, the convergence and accommodation stood in a causal relation? If not, why should the eyes so often converge rather than diverge in alternating squint.

INSUFFICIENCIES, HETEROPHORIA AND LATENT SQUINT

Donders' accommodation theory accounts in a logical way for these. Worth's theory of fusion accounts for them not at all; in fact he asserts that latent squint and manifest deviations have an entirely different pathology, and that, while manifest deviations are due to a faulty fusion center, latent deviation, heterophoria, is essentially a motor anomaly. I do not subscribe to this doctrine at all. In my opinion latent muscular insufficiencies, in the main, have the same underlying cause as the manifest and in fact often become manifest. It is begging the question to say that where the latent divergence becomes manifest it is due to a defect in the fusion faculty, but not otherwise.

In order to reconcile and harmonize the two theories of squint, "accommodation" and "fusion," and to show that they are necessary one to the other in accounting for the complex of symptoms—loss of binocular vision, more or less complete; amblyopia, greater or lesser in the deviating eye; deviation of the visual axes; and suppression of the image in one eye—it is well to look at squint from a double viewpoint—the psychical and the physical.

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[5] Worth: Squint, Ed. 3, p. 144.

The accommodation theory, while it gives to the fusion sense a secondary position, emphasizes the physical side of the squint; for example, (1) errors of refraction, especially in cases in which that error is greater in one eye than in the other; (2) opacities in the refractive media or lesions of the fundus enfeebling the sight in one eye; (3) the variation in the angle of the visual lines to the corneal optic axis of the eye—the angle alpha of Donders, or gamma of Landolt and later writers; (4) paresis of accommodation; (5) length of the eyeball; (6) anatomic defects in the structure or insertion of the straight muscles, etc.

The fusion theory emphasizes the psychic phase of squint; for example, (1) faulty development of the fusion sense, or the power to fuse the images of the two eyes into one, with the resultant loss of binocular vision; (2) the psychic phenomenon of suppression of the image of one eye, especially liable to occur when the vision in said eye is reduced from any cause, (this, however, may occur when the vision is perfect in each eye, when the fusion sense is supposed to be congenitally absent).

Since Donders' time the physical phase of squint has been well understood and treatment has been applied in a more or less rational way to relieve the symptoms. For example, the error of refraction has been corrected; cycloplegics have been used, though unfortunately most of them in an incorrect way (that is, in both eyes at the same time, for a long period); and operations have been performed for placing the visual axes parallel. Furthermore, for a great number of years the absence of binocular vision has been recognized as a great factor in causing and maintaining squint, and various methods to remove the cause were devised and used in a more or less satisfactory way. We owe much to Landolt, Priestly Smith, Javal and others for their work on strabismus; especially are we indebted to Javal for his teachings on the value of orthoptic exercises; that is, the use of the occlusion pad and the various stereoscopic exercises. In later years great credit must be given to Worth for his recognition of the great part the fusion sense played in the production of squint, and the importance he gave to it in treatment. He asserts, and justly so, that it is of supreme importance to treat such patients very early and during the development period of the fusion sense, between the ages of 3 and 5 years, if we are to prevent amblyopia in the squinting eye and maintain the eyes parallel. His advice is to begin the treatment of squint as soon as it appears; to use atropin in one eye only, the fixing eye, after the glasses have been prescribed, and to operate for the squint at any age, when the angle of deviation ceases to improve under orthoptic treatment. This is eminently sound advice and has done much to clear up this difficult question.

AMBLYOPIA, FIXATION, FUSION

Amblyopia may be congenital or acquired. Congenital amblyopia may cause squint and is seldom found in eyes that do not squint. The fundus of the eye is normal, so far as ophthalmoscopic appearances go, just as it is in cases of acquired amblyopia, so common in neglected cases of convergent squint. In the congenital variety, the peripheral field is normal in extent both for form and colors, and up to within 5° to 10° of the macula is almost normal in vision. The fovea centralis is at fault, and, although fusion of the outer contours of stereoscopic views may obtain in such cases, the central points do not.

In acquired amblyopia, the peripheral fields are normal for form and colors and the vision is often for all practical purposes lost, the macula and the surrounding region suffering most, while the peripheral region is also markedly reduced, often to counting fingers. In cases in which vision is reduced to below 20/200 fixation as a rule is abolished.

Furthermore, certain regions of the fundus may become amblyopic, as in a horizontal space extending from the macula region, in which the patient can supress the image. By placing a prism apex up or down, and adjusting the image on a more sensitive point in the retina, diplopia is at once elicited. Again, in an eye that has squinted for a long time a new or "false macula" may be formed, that is, a certain point in the retina becomes more sensitive and assumes the function of the macula to such an extent, in fact, that when the eye is straightened by surgical means, monocular diplopia results; or, if both eyes are left open, triplopia results, which at times persists for months. I myself have reported two such cases.

The chief function of the fovea centralis is fixation; it is also very sensitive to form perceptions. Javal and Tscherning both have laid great stress on fixation in the act of binocular single vision. Javal[6], says: "One realizes that the dimension of the point of fixation is not materially larger than the least visable point," and remarks, "If fixation had only for its object to bring the image of the object on the most sensitive portion of the retina, it would not add to its service that it should take place with such a wonderful precision."

Fortin,[7] has called particular attention to the fovea as the fixation center and also as to its extreme sensitiveness to form and for vision.

The extreme smallness of the retinal surface occupied by the fovea centralis is first pointed out; its entire diameter being not more than ¼ to ⅓ of a millimeter, while the central portion of the fovea, which alone takes part in fixation, is not more than two to three microns, 1/500 to 1/350 millimeter, in diameter. Javal and Tscherning also have called attention to the extreme minuteness of the fixation point in the fovea; and Fortin says, from his own personal experience and observations he can state that the angular error of fixation is less than a minute, which corresponds to a retinal displacement of but two microns, a displacement which is less or equal only to the width of a foveal cone. It is an important point in the study of the anomalies of fixation, and one that should not be lost sight of, that very small lesions at the fovea or in the optic nerve fibers that go to it may cause the loss of fixation. Fortin's experiments with specially constructed stereoscopic pictures relative to binocular fixation and fusion of images are of interest here. He comes to the conclusion that dissimilar images, let them be ever so small, if they fall directly on the fixation centers in the two eyes cannot be fused. In some specially constructed pictures the outer part of the pictures could be fused even when markedly dissimilar, but the entral portions could never be fused unless they were identical in size and shape.

"In order that iso fixator vision be realized not only must the cerebral centers where fusion of images take place be intact, but moreover the two small images which are identical and superposable must fall at the same time on the two points of fixation. When the two eyes are sound, I do not believe that it is possible to fuse two dissimilar images, however small may they be, when we allow them to fall at the same time on the points of fixation.

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[6] Javal: Manuel de strabisme.

[7] Fortin: An Essay on the Physiology of the Fovea Centralis, Arch. d'Ophth., October, 1906.

“On the other hand, outside of the fixation points, one may succeed with the stereoscope in fusing images presenting dissimilar contours, and this when the fixation of both eyes is rigorously maintained upon superposable segments.”[7]

In my practice I have had a most interesting case of this kind.

A young man, aged 19, came to me ten years ago, January, 1900, with slight myopia in each eye:

R. V. = 20/50 — : 20/20 + w — 1.D = — 25 C 180
L. V. = 20/70 — : 20/20 + w — 1.D = — 25 C 180

Read Jaeger No. 1 binocularly at four inches. When looking in the distance and not paying attention, the left eye diverged 5° to 10°. Single binocular vision for distance and near. Glasses were ordered. January, 1903, the patient reported he has not worn the glasses for a long time—a year. Divergence 10°, 15°, left deviating, though the patient could at will use the eyes together. He used the right eye for distance and the left eye for near work as a rule. Glasses were ordered again. Panas' operation on external recti was performed February 13. On February 20, the patient had single binocular vision for all distances, for the candle and Kroll pictures. With the Worth amblyoscope the patient had fusion of the first degree; that is, he perceived objects simultaneously in the two eyes, but could not project them properly. For instance, he could not place the bird in the cage. When he got them near together either the bird or the cage disappeared. Strange to say, however, he could fuse the somewhat dissimilar images of the boy with one leg off and the other with the head off, making a complete figure. Also the proper fusion of the circles making a pot, which Worth claims to be indicative of the third or highest degree of fusion, he got perfectly and readily, telling at once if the small or large end of the pot was toward him. The defect in this particular stereoscopic picture of Worth's is that there is no small central spot. Small central spots being put in these circles on either side, the patient failed to fuse them, showing a central defect, although the peripheral fields were fused. Hering's drop test showed a central defect also. In fact, I consider Hering's test the most valuable one of all for testing single binocular vision of the third dimension.

TREATMENT

The methods and measures used in the treatment of squint may be best considered under two general headings; first, non-operative or orthoptic treatment; second, surgical treatment.

NON-OPERATIVE OR ORTHOPTIC TREATMENT

The different measures of this line of treatment may be considered under the following headings: (1) correction of the error of refraction; (2) use of the occlusion pad; (3) the use of cycloplegics in the fixing eye; (4) stereoscopic exercises for training the fusion sense.

1. Correction of the Refractive Error

In all cases of squint the refractive error should be corrected under the influence of cycloplegics. If hypermetropia or hypermetropic astigmatism is present, as is most frequently the case in convergent squint, the astigmatism should be corrected in full, but not the hypermetropia. With very few exceptions, I have made a reduction of 25 to 1 D from the total of hypermetropia, depending on the amount of the total hypermetropia. In small degrees I reduce only 25 D; in the higher a larger amount up to 1 D.

Most text-books direct that full corection be given in these cases. Worth's book is the one exception. Like Worth, I have found that full correction of the hypermetropia, by dimming the vision for the distance, exerts a bad influence on the squint itself, in fact, simply serves to increase the defect; for this reason I have long since ceased giving full correction of the hypermetropia in squint cases.

In cases of antimetropia the hyperopic eye should be corrected as in the cases in which both eyes are hyperopic, while the myopic eye should have full correction, if there is a small or moderate degree of myopia, and almost full in high amounts. If the vision in the myopic eye is very poor, not owing to refractive errors, a plain glass should be given for this eye. By simply correcting the hyperopia a convergent squint in the myopic eye is sometimes relieved. I have some such cases in my case-books.

The questions, first as to the age of the patient when glasses should be given, and second, the length of time after the onset of the squint, are still matters of much discussion among the profession. Worth asserts that no infant is too young to wear glasses should they be required, and he reports cases in which he has fitted spectacles on patients of the tender age of 4 and 5 months. I have never prescribed a pair of glasses for a child under 18 months of age. Like the great majority of my confrères I have deferred giving glasses to infants, depending on the use of the occlusion pad, and atropin in the fixing eye only, to hold the vision in the deviating eye until the patient was old enough, say 2 years old, to have glasses. In private practice parents strongly object to having glasses placed on an infant's eyes, and I have found it difficult to have glasses ordered at 2 years of age. In hospital practice patients are rarely ever brought to us before that age, and even here the American parents refuse to have glasses placed on infants. When glasses are ordered they should be for constant wear.

2. *The Use of the Occlusion Pad*

In infants the occlusion pad may be applied to the fixing eye and held in position by a bandage. This is kept on during the day and removed at night. In older children the pad may be held in place by adhesive tape. This treatment is kept up for three or four weeks, when it should be discontinued and atropin 0.5 per cent. solution, instilled into the eye every morning. By paralyzing the accommodation in this eye, often the other eye will be used to fix with, first for near objects, then for distant, after a few days or weeks treatment. Then the atropin should be left out of the better eye for a week or two to see if the child will not use the eyes together. If the squint returns in the original eye, atropin must be instilled again into the fixing eye, until the other eye is used. This alternating of the squint from one eye to the other can be kept up by the use of the atropin in the fixing eye only until the patient is old enough to have glasses. In older children, whose vision can be tested by some method, as the ivory balls recommended by Worth, the occlusion pad is kept on the fixing eye from two to six weeks, when it is removed. If the vision in the originally squinting eye is not too poor, not less than 20/100, atropin may be used in the fixing eye. This is kept up until the patient can fix with the squinting eye. At first the patient fixes with the originally squinting eye for the near point, and with the atropinized (original fixing) eye for the distant point. After a few weeks the patient will fix both for the near and the distant point with the originally squinting eye, and squint all the while with the originally fixing eye. The patient, of course, is wearing glasses which correct the refractive error. After we have succeeded in making the patient fix for all distances with the squinting eye for some weeks, the atropin should be left out of the originally fixing eye. If the originally fixing eye continues to squint after the atropin has been removed from it, it may be necessary even to put atropin for a few days in the originally squinting eye, which now is the fixing one. We thus keep up the alternation of squint, by the use of the atropin, first in one eye and then in the other, in order to develop the vision and fixation in each eye and to place the patient in condition for the fusion treatment

Stereoscopic Exercises

Once we are able to use the stereoscope and to develop binocular vision in these little patients, especially to develop the fusion sense to the second or third degree—that is dimensions in the third degree—we have brought to bear a most powerful influence, the fusion sense, to correct the deviation and also to maintain the eyes parallel.

We are indebted to Javal for the first minute directions in stereoscopic exercises. Since his day there have been many others who have written much on this subject and devised many stereoscopes. Worth lays great stress on these exercises and asserts with Landolt and others, and justly so, I think—that they are of supreme importance in the cure of squint. The earlier begun the more efficacious they are, because the fusion sense is developed by the end of the sixth year, and to be of the best service these exercises must be begun and practiced between the age of 3 and 5, when the result is both satisfactory and brilliant. When undertaken after this age the result is slow to come and not very satisfactory, as the fusion sense is never able to be restored fully and binocular single vision seldom develops in the highest degree. There have been a few cases reported, however, in which binocular vision has been obtained long after 6 years of age. In cases of essential alternating squint these exercises are of little or no value, as the patient cannot be made to fuse the images, although in alternating squint the vision is perfect in each eye. Hence it is useless to waste time in trying stereoscopic exercises on such patients. Nor are these stereoscopic exercises of much value in cases of neuropathic squint.

In congenital squint stereoscopic exercises are of no use whatsoever. And, as pointed by our Chairman, Dr.

Posey, in a paper[8] read before this Section three years ago, from the standpoint of treatment, the necessity of an early differential diagnosis between congenital and concommitant squint cannot be insisted on too strongly, for each manifestly demands different measures for its correction. Nothing but operative measures are of avail in congenital squint, hence the folly of subjecting these cases to amblyopic exercises.

OPERATIVE TREATMENT

Convergent Squint

In half to two thirds of the cases, convergent squint is not relieved by orthoptic or non-operative measures. The time to operate, both as regards the age of the patient and the onset of the squint, has been and always will be, I suppose, a matter of opinion of each surgeon. The general consensus of opinion is, I believe, toward early operative interference.

1. As to the length of time after the onset, I believe it is a good plan to operate just as soon as the angle of the squint ceases to improve with the orthoptic measures Nothing is to be gained by waiting after this; in fact, much is to be lost. By surgical interference the eyes can be put relatively straight, when stereoscopic exercises can be used to greater advantage and often a complete cure result.

2. As to the age of the patient, rarely indeed will one be called on to operate on a child under 2 years of age, and seldom at that tender age. Orthoptic exercises as a rule suffice, up to the age of 3, at which time, or shortly after, stereoscopic exercises for fusion training can be brough into use, being followed by the operation when that shall be necessary. Occasionally in constant unilateral squint which does not improve, where there is false fixation, operation should be performed at 2 years of age, or even younger.

What shall the operation be! advancement or tenotomy? Here again opinion varies widely. Landolt for many years has advocated and practiced advancement almost to the exclusion of tenotomy, and he has many followers. He asserts that (1) by advancement he strengthens the muscles operated on, while by tenotomy the muscles operated on are weakened; (2) the eye is thereby placed in a better position—that is deeper in the muscle funnel and for that reason the muscles can act more powerfully; and that the fields of fixation are actually widened in each direction, while in tenotomy just the opposite conditions prevail because of the weakening of the muscles and the unfavorable position by the dropping forward of the eye following the tenotomy; (3) in advancement no sinking of the caruncle occurs as in the case of tenotomy; (4) in advancement there is no overeffect with deformity, as often happens after tenotomy; (5) by advancement the check ligament assists the action of the muscle operated on, while in tenotomy the muscle is liable to retract far back on the globe of the eye, and the check ligament actually diminishes the action of the muscle itself.

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[8] Posey, W. A.: Congenital Squint, THE JOURNAL A. M. A., Oct. 26, 1907, xlix, 1428.

Only in certain cases of insufficiency of the convergence and vertical deviations and in combination with the advancement operation in high degrees of squint, does he sanction or perform a tenotomy.

Tenotomy, however, has many advocates; in the first place, perhaps, because of the ease with which it can be performed; secondly, because it usually can be performed under local anesthesia; thirdly, because the patient does not have to remain in the hospital but a day or two; fourthly, if properly performed, there is but little danger of overcorrection and no sinking of the caruncle to speak of, or noticeable proptosis; fifthly, if an over correction does obtain the graver operation (advancement) can be done lastly and not firstly.

There are three classes of advancement operation: (1) freeing the tendon of the muscle and advancing same near the margin of the cornea, with or without resection of the tendon; (2) freeing the tendon, resecting it and reattaching it to the original insertion; (3) folding or knuckling the tendon without freeing it.

Of these three operations I prefer the first, especially in high degrees of squint. I practice what is termed the straight advancement operation. The conjunctiva and capsule of Tenon are advanced with the muscle and loop sutures are used to prevent cutting and slipping from the tendon of the muscle. The sutures near the cornea are deep enough in the sclera to obtain a firm hold.

I never resect the tendon of the muscle as far back as the belly of the muscle. In other words, I leave part of the tendon to secure the muscle fibers together. Once the muscle tissue proper is cut into the muscle fibers pull apart into inequal bunches and atrophy to a certain extent and lack uniform action as a whole. It is the same as if we cut the end of a rope which had been plaited together and turned all the fibers loose, when we cut back into the belly of the muscle. It is bad surgery and very undesirable in my opinion. If enough effect cannot be obtained by double advancement without cutting into the belly of the muscle, then tenotomy of the opposite muscles should be performed. In the resection operation with reattachment at the original insertion to secure enough effect, resection must be made into the belly of the muscle, which, as just stated, is objectionable, and, besides, in these operations, we too often have undereffect and must resort to a tenotomy finally to get sufficient results.

The knuckling, or pseudo-advancement operation, in my opinion should be abolished altogether, except for insufficiencies. It is unsightly, not effective, and, without exception, tenotomies of the opposing muscles must be performed later, to secure sufficient effect.

Of all the methods of tenotomy I prefer that performed by Panas in which the muscle is stretched before the tendon is cut. By this simple procedure several of the objections to tenotomy have been removed. First, by stretching the muscle it is lengthened and temporarily paralyzed. This serves a double purpose. It prevents the retraction of the muscle too far back on the globe and accelerates healing by allowing the muscle to lie quiet against the globe through the temporary paralysis of the muscle. Furthermore, by its attachment further forward on the globe it indirectly decreases the liability of an over-effect which sometimes follows a simple tenotomy. No tenotomy should, in my opinion, be performed without the muscle having first been stretched. This stretching can be performed under a local anesthesia and with but slight pain. Following this stretching operation the converging power, in my experience, has not been greatly weakened. In those cases in which there is excessive weakness or there is an over-effect, advancement of the same muscle may be performed later, but this is very exceptional in my practice.

As to the sinking of the caruncle, this does not follow at all if the incision in the conjunctiva and capsule is made properly, that is horizontally with the tendon of the muscle. What wonder that there is sinking of the caruncle when we have the incision made according to the following directions in a recent leading text-book on squint!

> With the forceps pick up the conjunctiva over the insertion of the tendon, then, with the scissors, make an incision about one-third of an inch long in a direction at *right angles* to that of the tendon. It is not *necessary* or *advisable* to suture the conjunctiva unless the conjunctival incision is unusually long. [Italics mine.—A. E. D.]

It is unnecessary to state, I suppose, that after any operative procedure for a squint, stereoscopic exercises should be practiced for a while to complete the cure and to reestablish single binocular vision, if that be possible.

As to our choice in the nature of the operation to be performed, advancement or tenotomy, we should be guided by the character of the squint and the effect to be obtained. Undoubtedly in the last few years the pendulum has been slowly swinging in the direction of the advancement operation in preference to tenotomy. I do not think, however, that we should be wedded to one operation alone, either advancement or tenotomy, but should practice that operation which promises to give the best result. In convergent squint of low degree, advancement should be performed in most cases, while in moderate and high degrees the stretching (Panas) operation is preferable. If enough effect is not secured advancement can be performed subsequently. In divergent squint of myopia I now invariably perform an advancement operation on the low and medium degrees; and combine it with tenotomy in the high degrees.

Some operators[9] advise that operative measures should be directed to the internal recti muscles alone, as convergence is the function at fault in all cases of lateral squint. But this I do not consider a good practice, since, in my opinion, it is founded on a mistaken etiology of squint.

One authority, Bettremieux,[10] asserts that the fixing eye should be operated on first, and the deviating eye later, if necessary. This is bad advice in two ways; first, but one eye at a time is operated on; second, most patients, especially private, would seriously object to it.

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[9] Ferri, L.: Ann. di Oft., 1909, xxxviii, No. 5; Ophthalmoscope, January, 1910.

[10] Bettremieux: Clin. Ophth., Oct. 10, 1907.

Since, squint is a binocular affection, with very few exceptions, the two eyes should be operated on at the same time.

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MEMORANDA

THE ADVANCEMENT OPERATION IN SQUINT *

VARD H. HULEN, A.M., M.D.
HOUSTON, TEXAS

Teachers of ophthalmic surgery have long advocated the more frequent performance of advancing and shortening operations, and some do them exclusively in preference to tenotomy for strabismus, but I believe that most of us are still very largely doing tenotomies. It must be that none of the various methods of advancement are considered entirely satisfactory, the simpler operation of tenotomy being more frequently chosen, hoping thereby to obtain an acceptable result.

Most ophthalmologists will agree that the advancement operation is more certainly corrective, physiologically more scientific, and functionally safer than tenotomy, and it is my conviction that a tenotomy alone should rarely be done in any case of squint.

A rather extensive observation of the work of various operators, including repeated visits to many of the large European eye clinics, convinces me that the ideal advancement operation has not yet been presented. There are certain requisites for this ideal operation, as they appeal to me:

First, the method must be simple and expeditious in order that the average patient may submit to it under local anesthesia and that the average operator may use it satisfactorily.

Second, when the operation is done under general anesthesia the determining sutures should be under such subsequent control that any possible deviation may be easily corrected when the true position of the eyes is ascertained.

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Third, the scleral suture should not depend in the least on the episcleral or conjunctival tissues for its support.

Fourth, one suture firmly introduced into the sclera is sufficient and it should be placed with the tendon insertion in view and before the muscle has been severed.

Fifth, the suture in the tendon must be firmly lodged to avoid a tendency to give or cut out, yet it must not be looped or knotted to the muscle, which would impede the vascular supply of the tissues involved and also make its removal difficult, thereby endangering the satisfactory adhesion of the tendon to the sclera in its new position.

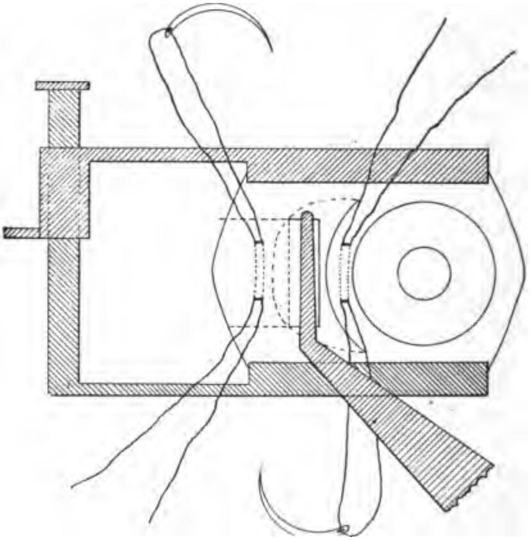

Fig. 1.—Method of introducing the sutures.

Sixth, and this is very important, the tendon and globe should not be pulled into the position for fixing by the process of tying the sutures.

An old surgical law, the observance of which is particularly important in ophthalmic surgery, which forbids that tissues be pulled into position by the sutures, is broken in nearly all the methods for advancement known to me. Traction aids will eliminate the operator's agony from broken sutures or cut and strangulated tissues due to vain efforts to obtain the desired position by straining at knots already tight.

Apropos of these statements I beg to describe an advancing and shortening operation which I first did five years ago and which, with slight modifications, has since seemed to have fulfiled my requirements. Reference to the two accompanying diagramatic illustrations will render a minute description unnecessary. Figure 1 shows the method of introducing the sutures; Figure 2 shows the position of the traction sutures in use and the method of knotting the fixing sutures.

The necessary instruments are two No. 28 full-curved sharp flat needles threaded with No. 6 iron-dyed black silk, the needles being placed in the middle of the sutures, a needle holder, fixation forceps, a strong pair of advancement or muscle forceps, tenotomy scissors, and a speculum; a strabismus hook is often useful.

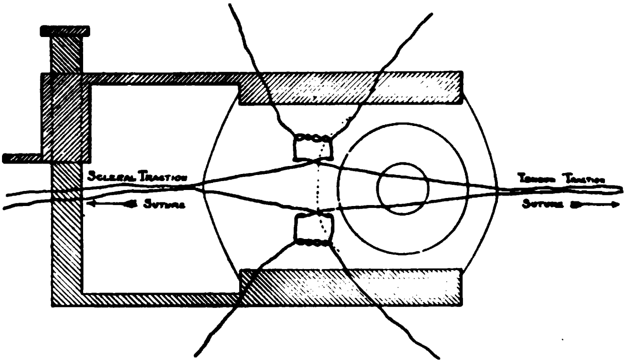

Fig. 2.—Position of the traction sutures in use, and the method of knotting the fixing sutures.

The procedures are the same for either the internal or external rectus. After complete anesthesia, local or general as the case may require, the speculum is introduced, the conjunctiva pinched up and incised vertically about 4 mm. from the cornea; the incision is extended above and below parallel with and corresponding to about one-third the circumference of the cornea, and the conjunctiva separated toward the cornea and the site of the tendon. Next the tendon is loosened along its upper and lower margins and clamped close to the scleral insertion with the muscle forceps, including the distal margin of the retracted conjunctival wound. The globe is held in perfect control with the muscle forceps, and, the tendon insertion being completely exposed, the scleral stitch should be accurately placed. The conjunctiva is first entered from without inward, then with the needle firmly grasped in the holder the suture is inserted vertically into the sclera close to the limbus, taking as deep and wide a bite as is safe, and the double suture drawn half-way through, again penetrating the conjunctival flap.

The tendon is next severed from its attachment, all the tissues as held in the jaws of the forceps are lifted and stretched into position for placing the second suture; the needle is made to penetrate from without inward through conjunctiva, Tenon's capsule and muscle at a point one-fourth the width of the muscle from one edge and as far back as we may wish to advance, the doubled suture is pulled half-way through and the needle is reintroduced at the corresponding point from the other border penetrating, from within outward, muscle, check ligament and conjunctiva.

The muscle forceps are then cut loose by severing the tissues as far from its jaws as one wishes to shorten, but not close enough to the suture to weaken its hold.

The needles are removed by cutting the sutures close to them. It will then be seen that there are really two sutures in the sclera and also two in the muscular tissues. One of the scleral sutures and one of the muscle sutures are crossed and used during the tying part of the operation for traction purposes only. The assistant has perfect control of the globe and the muscle by means of these traction sutures, and when he has brought them into the exact position required for correct fixation the operator ties loosely with a double twist the upper ends of the other sutures, the lower ends of those sutures are similarly tied, then he tightens the upper knot, now the lower one, and so on until the proper tension has been secured; each knot is then completed by the final twist, and the operation is practically finished. Supplementary conjunctival sutures will rarely be required.

Many details and important points not here described will readily occur to the surgeon performing this operation, or are common to all similar procedures.

Under general anesthesia, we cannot be sure of the correction, and it is one of the decided advantages of this method that the sutures used for traction can be left *in situ* until consciousness is regained. I usually allow them to remain until the following day, and if the squint has been materially over-corrected the tied sutures are removed, and the traction sutures are used to fix the eye in its correct position with but little discom-

At the conclusion of the operation done under local anesthesia we can be satisfied to remove the traction sutures immediately.

Also, should the surgeon prefer in any case to do the "tucking operation," the method should be precisely the same as described, except that the tendon is not severed, the muscle forceps are simply unclamped (the scleral suture will have been placed further from the limbus) then, when the traction sutures are used the muscle is smoothly folded on itself and any desired tension or position fixed by knotting the other sutures as in the strictly advancing operation.

Both eyes are bandaged and the patient is kept quiet. In five or six days the sutures are removed by cutting the upper one to the nasal side of the knot and the lower suture to the temporal side of its knot, or *vice versa,* and lifting them out.

It might be added that in doing this operation under general anesthesia, especially in marked squint, in which I combine it with tenotomy of the opposing muscle, a control suture is introduced through the tenotomized muscle and its stump.

In this method of advancing an ocular muscle attention is directed particularly to its simplicity, to the minimum amount of traumatism to all tissues, to the accuracy possible and security obtainable from the method of anchoring the scleral suture, the vertical introduction is decidedly advantageous, to the efficient "bite" of the tendon suture looped across the under surface of the muscle, to the perfect control of the parts to be united by means of the traction sutures which were obtained without additional suturing, and to the advantage of having already at hand a perfectly placed pair of sutures to be used, if required, for correcting any over-effect following the primary operation.

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THE SURGICAL TREATMENT OF SEPARATION OF THE RETINA *

CASEY A. WOOD, M.D.
CHICAGO

—As the subject of this paper has not been presented to the Section for many years, I though it might be profitable to discuss what seems to be the most important of the procedures now claiming our attention.

HISTORICAL REVIEW

Whether or not Saint-Yves (1722), Morgagni (1740), Wardrop (1818), and Panizza (1828) fully appreciated the condition later described as amotio sive sublatio retinæ, there can be no doubt that some of the findings referred to by them as hydrops subchorioidealis and hydrops chorioideæ internus were genuine examples of detachment of the retina.

That William Mackenzie[1] was, even during the preophthalmoscopic era, well acquainted with the pupillary and anatomic appearances of detachment of the retina and the need for surgical interference in its treatment is quite evident from a perusal of his earliest textbook.

He says, *inter alia:*

> It has been ascertained by dissection that a watery fluid is sometimes present in sclerotic staphyloma between the sclerotica and the chorioid whereby the latter tunic is pressed inward and the former outward. There are also good grounds for believing that a similar effusion forms occasionally between the chorioid and the retina. If the fluid collected in the latter situation is not evacuated by puncturing the staphyloma, it may accumulate to such a degree as to press the retina before

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[1] Practical Treatise on the Diseases of the Eye, London, 1830, 160.

MEMORANDA

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[1] Practical Treatise on the Diseases of the Eye, London, 1830, p. 460.

it, and having at last produced, by means of its continued pressure, an absorption of the viterous humor, it will gather the retina into a cord, as sometimes happens in arthritic and in mismanaged cases of syphilitic ophthalmia. A third situation of the hydrophthalmic effusion is between the retina and the hyaloid. Perhaps within the hyaloid is as frequent a seat of the watery effusion as any other; and in this case the structure of the vitreous body is broken up and dissolved.

I would remind you at the outset that retinal separation is not a pathologic entity, but a sign of several quite different diseased conditions. Doubtless, when its pathogenesis is more carefully studied in both its clinical and laboratory aspects, we shall be better able to assign to each case its proper treatment—to attack the problem in a rational rather than in the empirical fashion we are now obliged to adopt.

Before we consider the most effective forms of surgical intervention there are a few preliminary matters to be detailed, an important one being the relations of reattachment of the retina to central and peripheral vision.

The diminished visual vacuity and the lateral defects in the field of vision noticeable to the patient are, as a rule, much improved when the separated membrane is restored to its normal position. Still, this result cannot always be counted on, and its possibility or probability should be considered both by the patient and the surgeon before resorting to operative procedures.

It is not rational to suppose, when the percipient elements of the retina are from any cause seriously damaged, the optic nerve the seat of disease, or the ocular media cloudy, that a reattachment, however perfect, can, *per se,* be of much value to the patient. Such a situation, followed by reattachment, Hirschberg[2] calls "anatomische Heilung," because the result is purely mechanical and has nothing to do with the visual function. The postoperative condition in such cases is parallel when a mature cataract is extracted in a case of advanced retinitis pigmentosa; the operation may succeed, but the hemeralope is not much better off, *quoad visum,* than he was before the operation. The possible improvement in eyesight may, fortunately, be closely estimated from the history of the case, by testing the projection, by use of the perimeter and by ophthalmoscopy. In any event, it is wise to take a conservative view of the whole situation; it is better to promise too little than too much.

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[2] Centralbl. f. pkt. Augenh., 1891, p. 168.

RELAPSES IN THE COURSE OF OPERATIVE TREATMENT

The hopes of both patient and surgeon are often doomed to disappointment because of secondary detachment of the replaced retina. It frequently happens that, after a complete reposition of the separated membrane (with demonstrable increase in both central and peripheral vision lasting for a considerable time) the retina is once more torn away from the chorioid. This accident, due to various causes, has, in some instances, taken place while the patient was quietly lying in bed, under atropin, and wearing a bandage.

Within the past few months I witnessed in my own practice this mournful accident. The patient, a man, aged 55, had recovered almost his whole field for white. He also improved in central vision, from 10/200 and no Jaeger to 20/50 and ability to read coarse print, as the result of three "simple bisections," followed by rest in bed, atropin clycloplegia and pilocarpin sweats. He then "caught cold" and had a sharp attack of acute bronchitis, with severe fits of coughing. In a week, despite all treatment, the detachment, involving the macular region and about one-fourth of the retina in the tempero-inferior quadrants, was as pronounced as before and vision rapidly sank to its former level.

A ray of comfort and hope is thrown on this discouraging fact in the surgical conduct of separated retina in that a number of brilliant and permanent cures have followed persistent treatment and the repetition of operations, in spite of these relapses. In my opinion, it is desirable in the preliminary discussion with the patient of the "pros and cons" of proposed operative measures that this irregular course of the disease be frankly stated. No surgical intervention should be undertaken unless all parties to it are willing to have the patient submit to repeated operations so long as there is a chance of recovery. Deutschmann, for example, has finally succeeded in several cases of relapse, after operating a dozen times or more.

SPONTANEOUS REATTACHMENT OF THE SEPARATED RETINA

Instances of this happy event, which Hirschberg calls "physiologische Heilung," have been reported by a number of observers, although authors greatly vary in estimating their frequency.

Deutschmann, in 300 cases, has seen 3 spontaneous recoveries, or 1 per cent., Hirschberg has seen 4 examples in 338 cases, while Uhthoff reports a much higher proportion—28 cases out of 337—about 8:30 per cent.

Milliken[3] reports a case of detachment of the retina, confined to the macular region, occurring in a fairly healthy man, that resulted in practical recovery without treatment.

H. M. Post[4] gives a history of two cases, in one of which the retina resumed its proper position while the patient was in bed waiting for the removal of a cataract in the other eye. In another patient the reattachment occurred without any known cause and without treatment.

This subject is exhaustively discussed by Müglich,[5] and later by Spümer[6] in the light of case histories from Uhthoff's clinics in Marburg and Breslau. In a number of these cases there remained slight defects in the visual field or small area of unattached or imperfectly attached retina, not noticed by the patient.

In some instances, the period of observation (less than a year) was not protracted enough to assure oneself that a return of the separation might not take place. In my judgment, one may place in the category of physiologic cures quite a number of replacements thought to be due to rest in bed, sweats, dionin, mercurials, iodids and other kinds of medical treatment, not to mention those following minor surgical interferences—subconjunctival injections, cauterization of the sclera, and the like. In any event, Müglich gives the histories of 136 reported cases (1891) of detached retina in which there was complete replacement of the membrane without resort to any surgical treatment whatever, and these figures by no means exhaust the list to the year 1910.

PROGNOSIS IN OPERATIVE TREATMENT

Even under favorable conditions permanent cure of this formidable disease calls for the exercise of much patience and endurance both by the surgeon and the sufferer, for the outcome is at least doubtful. One can, however, give a fairly definite reply to anxious enquirers after fully considering the causes, character, extent, duration and the coincident ocular changes of a particular example of retinal separation.

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[3] Western Reserve Med. Jour., September, 1895.
[4] Amer. Jour. Ophth., May, 1907.
[5] Inaug. Diss., Marburg, 1891.
[6] Inaug. Diss., Breslay, 1904.

In a general way it may be said that, as Sattler[7] tersely puts it, the smaller the detachment and the more recent the case the more encouraging the prospect.

Schöler[8] found in his experience that those cases most successfully treated are recent and present a clear vitreous and a bagging of the detached retina, thus indicating the presence of a small quantity of subretinal fluid. He regarded as unfavorable concomitant disease of the media, especially a fluid and turbid vitreous, high myopia, extensive detachment of the retina and marked disease of the chorioid.

In considering the propriety of submitting the patient to surgical measures it must not be forgotten that a committee of the Societe Francaise[9] ended its report on all operations known to the members at that time with these words: "Since we cannot affirm the certainty of any operative measure it may be stated that, as a rule, it is good policy to abstain from any surgical interference in the treatment of detached retina."

However, at the present time, we are able to take a more encouraging view of the situation.

WHAT CONSTITUTES A CURE OF RETINAL DETACHMENT?

In my limited experience of this affection the patient is generally satisfied with useful central vision and the permanent disappearance of the lateral cloud in his visual field, though the reattachment be incomplete. On the other hand, even if there is a satisfactory anatomic cure from the surgeon's standpoint, the sufferer is, of course, not interested in that fact when his eyesight is not distinctly improved as a result of the treatment.

That a patient with detached retina may be properly referred to as cured, the reattachment should be complete, or so nearly complete that he does not complain of symptoms, and the retina has retained its normal position for at least a year.

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[7] Deutsch. med. Wchnschr., 1905, Nos. 1 and 2.

[8] Zur Operativen Behandlung der Netzhautablösung, Berlin, 1889.

[9] Bull. et mem. de la Soc., Française d'ophtal., 1887, p. 67.

SUPPLEMENTARY (NON-OPERATIVE) MEASURES

In all, or nearly all, forms of surgical intervention various kinds of medical treatment are also prescribed. While these operative aids are referred to because of this fact, it is only fair to add that numerous cures have been claimed for one and all of these non-operative measures alone, as well as for almost any two or three of them combined.

Perhaps the most important remedy is the prone position in bed for weeks at a time, varied by daily removals to a couch or lounge. During the period of rest the patient should studiously refrain from any considerable exertion and must avoid straining at stool, sneezing, hawking, laughing and, above all, coughing. During this state of complete relaxation he may, at the discretion of the surgeon, take such supplementary treatment as the case seems to demand.

Many observers combine with this form of rest cure the use of the artificial (Heurteloup) leech, atropin, simple protective or compression bandages, tinted glasses, a darkened room, laxatives, sudorifics, a restricted diet and the employment of certain drugs said to have a specific effect on the vitreous changes, chorioidal disease, subretinal effusion and other accompaniments of the disease.

The most important of the internal remedies are large doses of potassium iodid, or sodium salicylate (Gifford), combined with sweat baths, with or without pilocarpin.

SIMPLE SCLERAL OR SCLEROCHORIOIDAL PUNCTURES—POSTERIOR SCLEROTOMY

This operation is intended to give vent to the subretinal fluid which, from the earliest years of the ophthalmoscopic era, was known to be an almost constant accompaniment of ablatio retinæ. It was the first rational operation performed for the relief of the disease and was first recommended and practiced by James Ware[10] in 1805. Ware's own words are:

> The operation was attended neither with difficulty nor danger. It consisted simply in the introduction of a common spear-pointed couching needle through the tunica sclerotica, a little further back than the part where it is usually introduced for the purpose of depressing a cataract. As soon as the instrument entered the eye a yellow-colored fluid immediately

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[10] Chirurgical Observations Relative to the Eye, 1805, II, 514.

escaped, sufficient in quantity to wet a common handkerchief quite through. The needle was continued in the eye about a minute, in order to give the fluid a more ready way to come out; and as soon as it was withdrawn the discharge ceased. The tension of the eye was considerably diminished by the operation. A compress dipped in a saturnine lotion was bound on it, and the patient put to bed.

In the modern operation the point of a broad needle or narrow cataract knife is, by the aid of the mirror, passed through the bulbar wall just far enough to tap the postretinal sac. The retina itself is not wounded. The instrument is then withdrawn and in this act turned slightly, to allow a portion of the fluid to drain away. This maneuver may be repeated almost indefinitely at proper intervals, say, of three days or a week. Atropin should be used, and the patient is kept quiet in bed.

Scleral puncture seems to hold its own to the present time and, alone or in conjunction with other forms of treatment, is practiced more frequently in detached retina than most surgical procedures. Cures following its performance are not uncommon, and, when practiced within proper scleral areas, it is practically devoid of danger.

Greenwood,[11] for example, gives an account of a case treated by this means with improvement that was not, however, permanent.

De Schweinitz has had good results with scleral puncture when it is followed by large (30 mm.) subconjunctival injections of physiologic salt solution (q. v.) and has not found it necessary to increase the strength of the sodium chlorid solution beyond 5 per cent. Subsequent to this treatment the patient should remain in bed.

An instance of cure is reported by W. H. McMullen.[12] The detachment had persisted for eleven months, and after repeated punctures of the sclera, combined with rest in bed and a bandage, the patient entirely recovered.

M. Sachs has made a slight modification in the foregoing, in that he makes a small incision behind and parallel to the equator, and through it passes a sickle-shaped knife into the eye. In withdrawing the blade it makes a decided incision of the intraocular membranes and so increases the area of cicatricial exudation and subsequent adhesion of the wounded tissues.

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[11] Ophthalmology, January, 1905.
[12] Trans. Ophth. Soc. of the United Kingdom, 1907, xxvii, 124.

SCLERAL PUNCTURE WITH INCISION OF THE DETACHED RETINA

As early as 1863 von Graefe[13] advised and practiced discission of the detached retina, an operation which he performed over fifty times. Only in one instance was this procedure followed by the loss of an eye. In about one-half the cases improvement was observed at once, although better vision was claimed for a year and longer in four instances.

DeWecker, Arlt, Bowman and others gave this procedure a fair trial with occasional good results, but it proved, on the whole, to be so unsatisfactory that it was finally abandoned. In more recent times it has received some support and has had a few advocates.

PUNCTURE OF THE EYEBALL WITH THE GALVANOCAUTERY

DeWecker and Masselon[14] were the first to employ this form of treatment, intended to bring about adhesive inflammation between the chorioid and the replaced retina.

The point of the electrocautery, heated almost to whiteness, is cautiously pressed against that (previously denuded) part of the scleral wall corresponding to the detached area and allowed to burn its way into the sac at the site of the punctures previously made with the knife. The cautery point is then immediately withdrawn and the eye treated, as after a major operation, with a protective bandage, atropin and rest in bed. If no serious reaction sets in it is repeated as often as necessary to bring about a cure.

J. A. Craig[15] reports a case of retinal separation associated with 8 D. of myopia that seems to warrant the efficacy of this method. Simpler means having failed, scleral puncture was resorted to and reposition of the membrane followed, but became once more detached in four days. Again scleral puncture was tried, reinforced by galvanocautery application to the sclera. The separated retina now remained in position eight days. Again the sclerotic was punctured and the galvanocautery applied more vigorously. After this last treatment there was no relapse and twenty months later vision was 6/6.

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[13] Arch. f. Ophth., 1863, xv, 3, 85.
[14] Ann. d'ocul., 1882, lviii.
[15] Brit. Med. Jour., Dec. 20, 1905.

Wernicke[16] reports on 422 patients with retinal separation examined in the clinic of Uhthoff. Of this number, 36 patients were cured or greatly relieved; 8 were cured by operative treatment; 10 by rest and other minor measures, and 18 recovered without treatment. Wernicke is much in favor of the galvanocautery, which, he believes, will best secure extensive adhesions of the retina to the chorioid. In the statistics just referred to, of 2 out of 13 cases the retina was entirely reattached by the employment of this measure.

Elschnig[17] gives a complete account of this operation, a part of which I take the liberty of translating.

> The sclerotic is exposed by a meridional incision through the conjunctival tissues overlying the scleral coat which, after bleeding has stopped, is punctured at half a dozen or more points with the red-hot galvanocautery. This minor operation is done under cocain-adrenalin anesthesia, or, in the case of very sensitive patients, subconjunctival cocain injections may be employed. The conjunctival folds of transmission between two of the straight muscles are taken up with a fixation forceps and slit right to the corneal margin with scissors. The underlying fibers of Tenon's capsule are also cut through, thus making a wound 8 to 12 mm. long.
>
> The edges of the wound are then separated by means of hooks, the eyeball rotated with a fixation forceps in the opposite direction so that the sclera in the neighborhood of the equator is freely exposed. It is best to hold the wound edges apart with two small (strabismus) hooks—Stevens act very well. It is in the sclera thus exposed that the burned points—five or six are generally sufficient—of the cautery are placed. Care must be taken not to perforate the scleral wall.

Sattler, having placed the cold cautery point in the wound, afterward turns on the current until the cauterization is completed.

If, on removing the cautery-point from the wound, it is found adherent to the tissues, the current should be again applied, when it is more easily removed from the charred tissues.

The edges of the conjunctival incision are now brought together with silk or catgut, the wound is dressed and a bandage applied. The sutures may be removed after two days.

The cauterization may be repeated as soon as the eye is once more free of irritation. If, however, the application is too frequently made, there is some danger of one of the straight muscles becoming attached, by scar tissue, to Tenon's capsule.

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[16] Klin. Monatsbl. f. Augenh., February-March, 1906.
[17] Czarmak's Augenarztliche Operationen, Ed. 2.

There can be no doubt, as Wernicke and others have shown, that this method does induce marked inflammatory adhesions of the retina to the chorioid.

H. Dor does not like the electropuncture, but prefers the actual cautery in the form of Guersant's needle, because that instrument is provided with a "stop" which prevents too deep perforation of the sclera. This needle is heated red-hot in an alcohol flame and applied to the conjunctiva. The objection to this method is that it brings about a marked contraction of the ocular conjunctiva, as well as cicatricial adhesions of the overlying tissues to the sclerotic.

Elschnig considers the principal value of all these local cauterizations to lie in the fact that the sclera is contracted by the formation of scar tissue in it through these burns, so that the site of the eyeball itself is reduced. In other words, galvanic and other forms of cautery bring about the same result that one gets in Mueller's operation. He has employed the cautery in connection with scleral puncture and believes that, in this way, he obtains better results than ordinarily flow from either method alone.

H. Dor[18] reports over 40 cases of retinal detachment in which he makes use of a combined treatment, employing the artificial leech, punctiform cauterization and the injection into Tenon's capsule of 10 per cent. sodium chlorid solution. Seven of the patients were decidedly improved, 5 satisfactorily improved and in 3 there was small improvement. In 10 cases there was complete failure.

SUBCONJUNCTIVAL INJECTIONS

The *modus operandi* of subconjunctival injections in detached retina is not fully understood. Whether they act (in virtue of the local irritation) by stimulating absorption of the subretinal fluid, at the same time increasing the watery contents of the hyaloid cavity, or whether the process of osmosis (exomosis of the subretinal fluid associated with endomosis of the subconjunctival solution and pouring out of serum from the ciliary vessels into the vitreous chamber) best accounts for the beneficial results remains to be determined.

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[18] Bull. de la Soc. Franc., 1907.

It may be mentioned, in passing, that dionin, inasmuch as it acts in a manner similar to saline subconjunctival injections, is indicated as a substitute for these agents in the treatment of displaced retina and, in some hands, appears to be of some value.

DeWecker,[19] probably influenced by Rachlmann's[20] earlier work, was the first to use this remedy extensively. He injected at first, without much effect, simple salt solution into Tenon's capsule, but later[21] added small proportions of gelatin (3 per cent.) to increase the local irritation and consequent diapedesis of the intraocular fluids. He found the effect on the detachment more marked than before and noticed that the disease of the vitreous was distinctly improved.

In 1896 Lodato[22] gave a favorable account of the use of sodium chlorid injections in 15 cases of separation of the retina. In 12 of these there was almost total reposition of the membrane; in two only was there complete increase in the central acuity.

During the following two or three years, in consequence of continued favorable reports, there was a widespread employment of this remedy. Gotti,[23], Mazzoli,[24] Dor, sr.,[25] and others.

Dianoux prefers a mixture of 1 per cent. sodium chlorid and 4 per cent. cane sugar in distilled water. Of this, 4 or 5 c.c. are injected into Tenon's capsule on the first, second and fifth day of the treatment. He has found a series of ten such injections to be effective in detached retina.

Dor, sr., at the Ninth International Ophthalmological Congress, reported the results of treatment of 21 patients. Of these, 14 were cured or much improved, several of them having no relapse after four years. His methods included chiefly injections into Tenon's capsule of 20 to 30 per cent. solutions of salt, the application of the Heurteloupe leech to the temple, thermocautery puncture of the sclera at the site of the detachment, a compression bandage and rest in bed.

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[19] Traitencomplet d'Ophthalmologie, Paris, 1887.
[20] Graefe's Arch. f. Ophthal., 1876, xxii.
[21] Die Ophthal. Klinik, 1899, No. 11.
[22] Arch. di Ottalmologia, 1896, iv.
[23] Ancora Sulla cura dei distachi della retina, Bologna, 1898.
[24] Arch. di Ottalmologia, 1900, vii.
[25] Ztschr. f. Augenh., Sup. 2, 1899.

Marple[26] has used subconjunctival medication in three cases, but without permanent improvement. He began with 5 per cent. sodium chlorid and gradually increased it to 25 per cent., although the stronger solutions were extremely painful.

Guilbert[27] tried in three cases the serum-gelatin of deWecker and the serum of Trunecek with one cure and temporary improvement in the other two.

A. Maitland Ramsay[28] has taken all his cases of this condition occurring in hospital practice over a period of four years and reported on the results of treatment by subconjunctival saline injections. The exact nature of the saline varied in different cases, but the solution ordinarily used was from 5 to 20 minims of 1 in 2,000 bicyanid of mercury with 8 per cent. chemically pure sodium chlorid. Dionin was occasionally added to the injection. Ramsay lays great stress on the need of attention in every way to the patient's general health, and especially to the state of the bowels, during his period in bed.

The average number of injections was five, and the average duration of treatment one month, but prolongation of the period in bed is probably beneficial if the case is one which is improving. On the other hand, if, after from 14 to 21 days, there are no signs of improvement, the case may be considered incurable. There were 50 patients treated by this author, of whom 27 received no benefit whatever. Of the remaining 23, 10 showed very decided improvement. Of these 10, 5 afterward relapsed, the shortest period being 2 weeks and the longest 4 years after conclusion of treatment; of the remaining 5, 3 were satisfactory after one year and 2 were lost sight of. The other 13 of the benefited patients showed moderate improvement; some of them relapsed. Ramsay concludes that the favorable cases are few, the unfavorable many; but, however hopeless the latter may at first seem, it is always well, before coming to the conclusion that nothing can be done, to try the effect of such simple treatment. It can at least do no harm.

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[26] Rep. New York Eye and Ear Infirmary, 1904.
[27] La Clinique Ophthal., Sept. 10, 1904.
[28] Ophthalmoscope, November, 1907.

Ramsay gives the following as the formulas of the various fluids used by him in the subconjunctival treatment of amotio retinæ:

1

℞.

Sodii chloridi (chemically pure)	8 per cent.
Sol. hydrarg. bicyanid.	1 in 2000

Misce.

2

℞.

Dionin	1 per cent.
Sodii chloridi (chemically pure)	8 per cent.
Sol. hydrarg. bicyanid.	1 in 2000

Misce.

3—DOR'S FLUID

℞.

	gm.	
Sodii chloridi	5	
Sodii carbonatis		40
Sodii sulphatis		40
Sodii phosphatis		10
Potassii sulphatis		40
Aquæ destillatæ, ad	20	

Misce.

Staerkle[29] publishes the outcome of subconjunctival injections in 23 instances, with three cures. His conclusions touching this form of treatment are as follows:

1. The subconjunctival injection of common salt solution forms a harmless and almost painless means of stimulating the absorption of pathologic exudates within the eye.

2. Up to a certain point the stronger the solution the greater the effect. The writer employed 3 strengths only, 2 per cent., 4 per cent., and 10 per cent., and found these in every way adequate.

3. On the whole, the improvement in the anatomic conditions as well as in the visual fields and central vision, was more marked as time passed and the injections were continued.

4. The injections had a greater influence on recent, partial detachments than on long-standing and widespread examples of separation of the retina. Intermediate forms were variously affected by the treatment.

I may add my own experience of subconjunctival injections of 10 per cent. salt solutions in retinal detachment; it is that, as an aid to more serious operative intervention, they are distinctly valuable and deserve a permanent place in our armamentarium.

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[29] Inaug. Diss., Basel, 1900.

DEUTSCHMANN'S OPERATIONS

Bisection, With and Without the Intravitreous Injection of Sterile Animal Vitreous.—In 1895 R. Deutschmann[30] of Hamburg first published his classic description of two operations for which he still claims results unattained by any other form of treatment. He is opposed to waiting until non-operative measures have been tried, but advises us to proceed at once to the more effective employment of surgical intervention. The simpler bisection (*"Durchschneidung"*) method he regards as especially valuable in the more acute or recent cases; the combined procedure he reserves for the advanced and less hopeful forms of the disease. Deutschmann claims that bisection reduces the tension on the retina, which in his experience can be so marked that it is impossible to reattach it without making one or several incisions through the vitreous bands. He evacuates the retinal and preretinal fluids and tries to produce small inflammatory adhesions between chorioid and retina. With the injection of animal vitreous into the posterior chamber he produces a mechanical pressure on the detached retina against the chorioid, and a welding of both membranes on an inflammatory basis, with simultaneous refilling of the eyeball. Relapses may occur with either or both methods, but under these circumstances he repeats the operations in an attempt to regain what has been lost. The author refers to the favorable statistics of Horstmann (6.66 per cent. of cures) and Uhthoff (7.50 per cent.) as the result of operative interference, but believes that much better success can be attained by his methods. As evidence he gives his own experience. To July 1, 1909, he has operated on 267 patients with retinal detachment. Of these he cured 70, or 26.1 per cent., improved 94, or 35.2 per cent., failed in 103, or 38.7 per cent. From these totals, however, he subtracts a number of patients on whom the operation was performed as an experiment, without the least chance of recovery of sight (the patients fully understanding the situation), with these results: cured 31.1 per cent., improved 41.3 per cent., not cured 27.6 per cent.

Bisection of the Vitreous and Retina.—This operation[31] is never employed in cases in which the detachment is above the equator; when one has to deal with such it is better to wait, without treating the patient, until the subretinal fluid has gravitated downward. After thorough disinfection and cocainization a two-edged linear knife, about the width of a medium-sized Graefe knife, is entered at a tangent to the globe (through conjunctiva and sclera well back of the ciliary region), passed quickly forward and then downward and backward, sweeping toward a counter-puncture at the other extremity of the ocular diameter, so as to cut in two as much as possible of the vitreous chamber without wounding any surgically important structure. The knife is drawn out as quickly as it was entered, being turned a little on its axis in order to allow the subretinal as well as some of the preretinal fluid to escape. This maneuver may be repeated as often as twenty times or more, with sufficiently long intervals between successive operations to permit the eye to recover from the reaction which, however, is generally small or *nil*. Of course, this interval must be a longer one if one of the larger retinal vessels has been wounded, or any other unforeseen accident should occur. A celluloid shield should then be applied to both eyes, or if a bandage be used it should be a loose one for the first 24 hours. After the first day only the eye operated on is covered, and it must be kept under the influence of atropin during the whole period. The patient should be kept in bed 7 or 8 days, after each operation and results watched with the ophthalmoscope.

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[30] Deutsch. med. Wchnschr., 1895, p. 345; and Beitr. z. Augenh., 1895, xx.

[31] Beitr. z. Augenh., 1904, No. 59; Ophthalmoscope, August. 1907, p. 410, and November, 1909, p. 737.

As a rule, when these directions are strictly followed under careful asepsis the operation is without danger to the eye.

Combined Bisection and Intravitreous Injection of Animal Vitreous.—Deutschmann reserves this operation for those cases in which vision has sunk very low or in which other means of restoring sight have failed. He says that, while one must not expect too much from it, yet by its use he has been able to save a small percentage of eyes in desperate cases. He also claims that, carried out under full cocainization and with strict aseptic precautions, it does not endanger either the eye operated on or the fellow eye. The pupil should be fully under the influence of cocain.

The instrument employed by Deutschmann (glass syringe) allows only an advance forward of its piston. This arrangement is provided so that no deleterious suction can be practiced on the contents of the eye should the finger by chance be removed from the piston end. As nozzle for the syringe one may employ either a platinum-iridium cannula or a double-edged knife cannula. Deutschmann now employs ready-to-use sterilized vitreous body of absolutely fresh calf's eye, hermetically sealed in glass tubes. These are supplied by Dr. W. Mielck, Dammthor-Strasse, Hamburg. This chemist supplies two.kinds of calf's vitreous: No. 1 is made by the filtration of freshly-boiled vitreous body, afterward resterilized by boiling in hermetically sealed glass tubes. This preparation has a weaker action than No. 2, which is composed of fresh vitreous body inspissated at 40 C. *in vacuo,* and the residum taken up with physiologic salt solution—sterilized by boiling—so that the component parts of normal, but concentrated vitreous body are contained in it.

The technic of this intravitreous operation as given by the author is as follows:

> To bring the retina once more as close as possible to the chorioid by means of the pressure of the injected animal vitreous it is, of course, necessary to get rid of the subretinal fluid. If one uses the point of the ordinary platinum-iridium cannula then the procedure is as follows: The syringe, filled with the animal vitreous, is best introduced in the region of the ora serrata, somewhat outward and downward. It is given to the assistant to hold while the operator, with the double-edged linear knife makes the usual simple bisection downward. After the completion of this maneuver, he, with the syringe, injects into the eye very slowly some of the contents of the barrel. It is generally sufficient to push forward the piston from 1.50 to 2 divisions, according to the consitency of the eye. Then the syringe point is withdrawn and the puncture closed with toothed forceps for some minutes, that none of the fluid injected may escape from the eye. To use the syringe with the cannula-knife, omit the usual bisection and insert knife point of the syringe, filled with animal vitreous, in exactly the same way as is directed in the bisection operation with the double-edge knife. One can introduce the cannula-knife up to the point of the counter-puncture but in all cases avoid moving the point from side to side.
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> On the introduction of the syringe the subretinal fluid flows out. Then one immediately presses the syringe piston forward, thus making the injection. The point of entrance is in this case also held together with forceps after the removal of the syringe.
>
> After the operation, both eyes are lightly bandaged for twenty-four hours, then one eye only. Further measures depend on the reaction shown by the eye. This reaction, again,

is dependent on the concentration of the animal vitreous used. "I must here state that to spare my colleagues every unpleasant experience, they must begin with the weaker preparation, and, since the operation can with perfect safety be repeated several times, gradually go on to stronger ones."

The ocular tension is generally reduced after these operations.

For the first injection one should dilute vitreous preparation No. 1 with equal parts of sterilized physiologic salt solution; for the second use the solution pure, and so on. Inflammatory symptoms, such as may appear at various periods up to the eighth day after the operations, can, as a rule, be easily controlled by atropin and hot applications. "If increase of tension sets in, one should at first wait quietly; only when the pain becomes very severe and perception of light is somewhat worse under the influence of the heightened tension should one interfere and do another simple bisection." Under ordinary conditions, however, it should always be borne in mind that after every injection the vitreous body will become more or less cloudy. This translucency gradually clears up completely. Even if it assumes a yellowish, abscess-like, appearance it becomes clear and normally transparent again in the course of a few months. It is only now and then necessary to assist absorption by hot applications or by an occasional salt injection.

The author's latest statistics[32] report 68 eyes treated by the use of animal vitreous. With repeated injections he cured 3 patients, improved 26, failed in 38, and 1 is still under treatment.

Since the publication of Deutschmann's first paper I have done the bisection operation on 10 eyes in 9 cases. Of these, there was complete reattachment of the retina with restitution of useful vision (Jaeger ÷ and 20/30) in one instance. This improvement continued for over three years—as long as the patient was under my observation. In two others decided improvement of central vision followed, but with incomplete reattachment of the retina. In the others there was little or no improvement.

I cannot understand why Deutschmann refrains from giving patients the benefit of the milder, non-operative forms of treatment (known to bring about occasional cures) while waiting for the gravitation of the subretinal fluid to lower levels. When the detachment in the upper quadrants is not due to malignant tumor or other incurable cause I am in the habit of making a thorough inquiry into the probable cause of the separation, and with rest in bed, pilocarpin sweats, iodids, subconjunctival injections and the use of other means, more or less rational, endeavor to bring about some alleviation of the patient's symptoms.

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[32] Ophthalmoscope, November, 1909, p. 739.

MUELLER'S OPERATION

Resection of a Portion of the Scleral Wall.—The originator of this operation. Leopold Mueller,[33] was led to perform it because of his belief that many cases of detachment are due to disproportion between the shrunken or shrinking vitreous humor and the ocular envelopes. He proposes a rather formidable but, he claims, successful remedy for this condition, no less than an attempt to reduce the size of the eyeball. Since it is impossible to attain asepsis of the conjunctiva, Mueller operates on the globe behind the equator.

Krönlein's resection of the outer orbital wall forms the first stage of this new operation. This preliminary being accomplished, the temporal aspect of the eyeball is thoroughly exposed. The external rectus is then divided, the cut ends being secured by fine sutures, so that they may be later reunited. The operator then carefully and slowly excises with a sharp scalpel a biconvex piece of sclera 20 mm. long (with its length parallel to the equator) and 8 to 10 mm. wide, in such a manner that its anterior edge lies 1 or 2 mm. behind the insertion of the external rectus. Its posterior margin should correspond to the equator. The edges of the scleral wound are now brought together by five small stitches. In the performance of this operation care must be taken not to injure the chorioid, but, just before tying the scleral sutures, the subretinal sac is tapped with a narrow knife and some of the fluid allowed to escape. The cut ends of the externus are then carefully approximated and the bony plate, skin, etc., readjusted. When the wound is closed the whole eyeball is smaller than before.

Mueller reports 3 cases in which he had done this operation, after which the separated membranes resumed and held the proper position for 10, 11 and 15 months, respectively.

It is, of course, too soon to pass judgment on this operation. Perhaps, in the majority of cases—those associated with the enlarged globe of extreme myopia—it may prove more valuable than any other operative procedure.

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[33] Klin. Monatsbl. f. Augenh., May-June, 1903, p. 459.

In this paper I have considered only those surgical methods that, in my experience, are most likely to be effective in this distressing condition. Such measures as iridectomy, electrolysis of the subretinal fluid, Schöler's operation of the intravitreous injection of iodin, injection of air into the hyaloid cavity, laceration of the retina, and many others are of historical interest chiefly. None of them is, in my opinion, so valuable as the procedures just detailed.

CONCLUSIONS

One who has made a study of the observations of others in the surgical treatment of detached retina and has added to it his own experience—though that may be limited—will, I think, come to these conclusions:

1. Inasmuch as separation of the retina is not a distinct disease but merely one sign—albeit a very important one—of several different affections, it is not to be expected that it is to be cured or much relieved in every instance by some particular operation. The "one-disease-one-operation" idea can have no place here.

2. A large percentage of retinal repositions, including an unknown proportion of those that follow operative measures, belong to the class of spontaneous cures. In such cases relief may have been assisted, hastened or rendered more or less permanent by the remedies exhibited, but the probability is that the patients would have recovered in any event.

3. So far as prognosis is concerned, the more hopeful cases are the recent, limited varieties—those produced by traumatism, postretinal hemorrhage and the like—as well as those resulting from removable causes. *Per contra,* old, extensive detachments, especially when associated with marked degeneration of the retina, vitreous and chorioid, are not likely to get well under any forms of treatment. A long-separated, starved retina rarely regains its lost functions.

4. Recurrence of the detachment forms a disappointing feature in the treatment of the disease, and this fact should be considered by both patient and surgeon when the subject of operation is broached. On the other hand,

it has been abundantly demonstrated that patients with separated retina have recovered after several relapses and after having submitted to many operations.

5. No patient should be regarded as permanently cured until at least a year after the replacement of the detached membrane. It is true that relapses are recorded after an interval of several years, but they are unusual.

6. When a patient presents himself it is best to try for, say, a month—indefinitely as long as improvement continues—non-operative measures. A thorough study should be made of the case to determine, if possible, the cause of the detachment, that it may be treated *secundum artem* and, perhaps, removed. With this causal treatment give subconjunctival injections, instil atropin and keep the patient in bed. Pilocarpin sweats, with iodids or sodium salicylate, are also generally indicated.

7. Failing to improve vision or to replace the separated retina by milder means, resort should be had to operation, and the question of the best operation for the case in hand at once arises. We know that the function of the retina gradually weakens the longer it is displaced; consequently the sooner one makes a choice of operation the better.

8. Deutschmann advises against his operation as long as the postretinal fluid is held within the upper quadrants of the globe. If we are debarred by this circumstance from the use of his methods, there can be no objection to the employment of scleral puncture, combined with punctiform cautery of the denuded sclera over the site of the detachment. Why should we wait until the retina is further detached and degenerated?

9. In those cases in which the sac occupies, as it generally does, the lower aspect of the hyaloid chamber, Deutschmann's method of bisection should be the operation of election, whether or not there be evident rents in the retina or visible fibrillæ in the vitreous.

10. Two weeks after an intrabulbar operation a careful examination of the eye should be made—with the electric ophthalmoscope (so that the patient may keep the prone position), hand perimeter, ward charts, etc.—to decide if improvement has taken place in the local conditions as well as in central and peripheral vision.

11. Assuming the eye to have recovered from any operative measure, i. e., to be free from either intraocu-

lar or extraocular inflammation, the same or another operation may be done in from three to six weeks' time.

12. In unpromising cases Deutschmann's intraocular injections of animal vitreous is in order, although Mueller's exsection of the sclera seems a rational though formidable procedure, which an improved technic and a wider experience may yet demonstrate to be of great value in the conduct of this extremely serious condition.

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MEMORANDA

THE STATUS OF VACCINE AND SERUM THERAPY IN OPHTHALMOLOGY *

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The immunization treatment of infectious diseases is conducted by the introduction into the system of (a) substances—antigens—which stimulate the tissues to the production of antibodies ("active" immunization); and by the introduction of (b) antibodies that are already formed ("passive" immunization). To the first class of substances belong tuberculin and the bacterins; to the second the serums (substances containing antibodies). If the powers of the tissues of an individual are exhausted so that they can no longer respond to the stimulus of an antigen it is useless and even deleterious to introduce the antigen. Hence the necessity for knowing the condition of the individual in this respect and of avoiding overdosage. In the introduction of antibodies (serums) the conditions of the tissues relative to their ability to develop antibodies is not a part of the question. The problem here is how much of antibodies is required and how much the tissues will tolerate without injury. It will be seen that "active" immunization will be efficient or of no value in proportion to the ability of the tissues to respond and in proportion to the proper estimation of the dosage, always provided that the antigen is suitable. Broadly speaking, bacteriemia is an indication that the tissues are exhausted and that they will not respond to added antigen. In the second case it is a question of proper antibody and proper dosage.

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VACCINS (BACTERINS)

TUBERCULOSIS

In the treatment of tuberculosis of the eye various tuberculins are employed.

1. Koch's original tuberculin, "T. O.," is a filtrate of an emulsion of bouillon culture of tubercle bacilli, containing products of the growth of the bacilli, substances extracted from the bacilli and the unaffected constituents of the bouillon. In process of preparation it is heated to a temperature of 70 to 90 C.; the heating is thought to impair its therapeutic value.

2. Koch's new tuberculin, "T. R.," is a centrifugalized extract of dried tubercle bacilli. The sediment obtained by centrifuging is dried, reground and dissolved in glycerin and water.

3. Bacillus emulsion, "B. E.," is made by filtering off the liquid of the bouillon culture and washing, drying and triturating the bacilli in a mortar until no whole bacilli remain. The powder is taken up in 0.8 per cent salt solution and added to 50 per cent. glycerin water so that 1 mg. of the powder is contained in 0.2 c.c. of the final preparation. The emulsion is subjected to a temperature of 60 C. in order to destroy any possible intact bacilli.

4. Bouillon filtrate, "B. F." (Denys), is the unheated filtrate of bouillon cultures of human tubercle bacilli.

It will be noted that the tuberculins are closely allied to bacterins; in fact, Koch's new tuberculin, "T. R.," and bacillus emulsion, "B. E.," are virtually bacterins.

Tuberculins may be prepared from bovine or human strains of the tubercle bacilli, may be used separately or may be combined in any proportion.

In any given case of ocular tuberculosis, it is desirable to ascertain the strain of bacillus responsible for the disease. If this is impossible, it is feasible to employ the tuberculin from the human or the bovine strain, whichever will give the best results; or a mixed tuberculin may be used.

As is well known, it is often necessary to resort to the reaction of the system or tissues in tuberculosis to make a diagnosis of tuberculosis of the eye, either by hypodermic injection by the conjunctiva (Calmette) or cutaneous (von Pirquet) test. It is now generally admitted that the only test that is of any value is that which induces a local reaction in the eye following the subcutaneous injection of tuberculin. A reaction to tuberculin, by whatever method employed, implies that there is a tuberculous focus in some part of the body, but unless the reaction is evident in the eye, there is absolutely no proof that the disease of the eye is tuberculous. Increased hyperemia of the ocular conjunctiva or of the growth and the surrounding tissues must ocurr. If this reaction takes place, the diagnosis is positive. If it does not take place, the probabilities are that the person is not tuberculous, but the possibility is not excluded.

The method of obtaining the general (and local) reaction of tuberculin by subcutaneous injections of tuberculin is admirably described by Dr. Trudeau as follows:

> The range of the patient's temperature is ascertained by taking it at 8 a. m., 3 p. m., and 8 p. m., for three days before making the test. The first injection should not exceed 0.5 mg., and if any fever is habitually present should even be less, and is best given early in the morning or late at night, as the typical reaction usually begins, in my experience, within six to twelve hours. Such a small dose, while it will often be sufficient to produce the looked-for rise of temperature, has under my observation never produced unpleasant or violent symptoms. An interval of two or three days should be allowed between each of the two or three subsequent injections it may be necessary to give, as reaction in very rare cases may be delayed for twenty-four or even thirty-six hours. On the third day a second dose of 1 mg. is given, and, if no effect is produced, a third dose, of 2 mg., three days later. In the great majority of cases of latent tuberculosis an appreciable reaction will be produced by the time a dose of 2 mg. has been reached. If no effect has been caused by the tests applied as above, I have usually gone no farther and concluded that no tuberculous process was present. If some slight symptoms, however, have been produced by a dose of 2 mg., it may be necessary to give a fourth injection of 3 mg. in order to reach a positive conclusion. Nevertheless it should be borne in mind that in a few cases the exhibition of even larger doses may cause reaction, when the smaller do not, and indicate the existence of some slight latent tuberculous lesion, and the negative result should not, when applied within the moderate doses described, be considered absolutely infallible. It is evident that the size of the doses given has much to do with the limitations of this method for usefulness, and the correctness of the conclusions reached by its application. The tuberculin used is also a matter of some importance, in determining the dosage, as different samples vary considerably in their efficiency. If the test be pushed to the injection of such large amounts as 10 mg. or more, as advocated by Maragliano, such doses are by no means free from the objection of occasion-

ally causing unpleasant and sometimes dangerous symptoms; and even if the amount given be not carried to the dose of 10 mg., which is known to produce fever in healthy subjects, it is likely that on account of individual susceptibility or the presence of some other morbid process in the body, reaction will be found to occur with the larger dose when no tuberculous process exists. The adoption of an initial dose so small as to guard against the absolute possibility of producing violent reactionary symptoms, and the graded increase of the subsequent doses within such quantities as are known never to produce reaction in healthy individuals, would seem to afford the best protection against unpleasant results and misleading evidence.

In the tuberculin treatment of tuberculosis of the eye, tuberculin "T. O." is used but little for therapeutic purposes because of its having been subjected to a quite high temperature. "T. R." and "B. E." apparently possess greater therapeutic value, although they may have been subjected to a temperature of 50 C. for a short time. "B. F." is thought to be the most efficacious.

The method of treatment (the diagnosis having been made) at present advocated by those of large experience is the method of von Hippel, beginning with a very small dose of "T. R.," "B. E." or "B. F.," not more than 1/500 mg., and increasing by 1/500 mg. each dose; the dose to be given every third day if no general reaction has been occasioned in the early treatment of the case; less frequently as the patient improves. The tuberculin should not be given if there has been any reaction until the temperature has returned to normal and has remained so for at least forty-eight hours. It is advised so to regulate the dose that the effect on the patient is just short of the general reaction. As the treatment advances, a larger dose will be tolerated, but the maximum dose should not exceed one milligram.

The tuberculin, properly diluted, is injected subcutaneously into the subcutaneous areolar tissue of the abdomen, subscapular region, or arm after the skin at point of puncture has been thoroughly rubbed with 95 per cent. alcohol. The puncture may be subsequently sealed with collodion.

In an article which I recently presented to the Section on Ophthalmology, Sixteenth International Medical Congress at Budapest, fifty-eight cases of tuberculosis of the eye, including tuberculosis of the eyelids, conjunctiva, cornea, sclera, iris, chorioid, and retina were cited. These cases occurred in the practice of ophthalmologists in the United States and Canada. Of this number, virtual cures were observed in thirty-five and improvement in fifteen cases. The form of tuberculosis that is least amenable to treatment is the conglomerate tubercle. This form occurs in the vascular tunic of the eyeball and in the optic nerve.

The preparations of dead bacteria used for inoculating individuals are termed vaccines. It has been conclusively proved that a vaccine which is prepared from the same strain of bacteria (autogenic), against which the vaccine is to be used, is the most efficient in the particular case. In other words, the vaccine is specific for the strain from which it is made. If this strain cannot be obtained for making the vaccine, some complementary element may be found in each of a number of heterogenous strains, the sum of which may almost equal the specific strain. The latter are termed "polyvalent" vaccines or "stock" vaccines.

Wright advises injecting the vaccine in the loose subcutaneous tissue as near the site of the lesion as possible and "up-stream" as regards the flow of the lymph, in order that the "opsonins" resulting may be carried as directly as possible to the disease area in the lymph-stream. The sites usually selected are the loose tissue of the back, the lumbar region, or the groin.

GONOCOCCIC VACCINE

As this micro-organism is not readily cultivated it is difficult to obtain autogenous vaccine. "Stock" gonococcic vaccine occurs on the market in bottles containing 1 c.c. of an emulsion in two strengths, one of 20,000,000 and one of 100,000,000. In regard to the dose, Cole and Meakins[1] gave an initial dose of 300,000,000 gonococci, and a dose of 1,200,000,000 did not produce any unfavorable symptoms. They say: "In no case have we seen the administration of gonococci vaccine do harm." It must be remembered that vaccines are antigens, and that their capacity to excite the development of antibodies depends on the capacity of the tissues to react to their stimulus and not on the size of the dose. It is held by the Wright school that the condition of the tissues in this respect can be determined by a study of the "opsonic index;" this study requires the time of a skilled laboratory worker, which is not always at the command of the clinician. Many clinicians are of the opinion that the opsonic index does not furnish data that are of any more value than the clinical manifestations; they rely on the local and general reaction occasioned by the vaccine and the effects on the course of the disease. Although large doses of gonococcus vaccine are well tolerated, the tendency now is to give smaller doses than formerly; it may range from 2,500,000 to 50,000,000. In a case of metastatic gonorrheal iritis which I recently treated successfully the initial dose was 2,500,000, subsequent dose 5,000,000 each.

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[1] Cole and Meakins: Bull. Johns Hopkins Hosp., June and July, 1907.

Gonococcic vaccine is regarded as valuable as an aid to the diagnosis of obscure affections due to the gonococcus. Irons[2] writes:

> A typical gonococcus reaction is characterized by a rise in temperature, often only slight . . . and a variable degree of malaise. The symptoms follow the injection in from eight to twelve hours and commonly last about twenty-four hours. Frequently there is a decided tenderness at the site of the injection, greater than occurs after the inoculation of the same dose of the same preparation in normal subjects. Occasionally there is a marked redness and edema, lasting from twenty-four to forty-eight hours. . . The degree of reaction is influenced by several factors. After small doses (20,000,000 to 50,000,000) the reaction was not marked, and in a number of early cases either did not occur or was overlooked . . . The reaction is in many subjects similar to that which follows injections of tuberculin in cases of tuberculosis.

In obscure cases of uveitis, iritis and metastatic conjunctivitis, the gonococcic vaccine promises to be of service in clearing up the etiology.

It is now generally recognized that gonococcic vaccine is of little value in acute gonorrheal infection either of the urethra or of the eye. Of seventy-nine cases of acute urethral gonorrhea tabulated by Duncan[3] "satisfactory" results were obtained in nine, slight improvement noticed in ten, no improvement in sixty. The cases of acute gonorrheal infection of the conjunctiva treated with gonorrheal vaccine known to me are only three in number. In thirteen cases of chronic gonorrhea occurring in females satisfactory results were obtained in eleven; no result in two. Of forty-six cases of gonorrheal arthritis, satisfactory results were obtained in forty-two; no result in four (Duncan). Of chronic gonorrheal affections of the eye, Posey (personal communcation) reports a severe case of uveitis not benefited, and Dr. S. Hanford McKee three cases of metastatic gonorrheal conjunctivitis. All ran a mild course. The vaccine appeared to relieve the pain greatly in the joints affected with gonorrheal rheumatism in these patients.

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[2] Irons: Jour. Infect. Dis., June 4, 1908.
[3] Duncan: New York Med. Jour., Nov. 6, 1909.

Two cases of gonococcal iritis in patients with arthritis in which fluid from the synovial sacs gave gonococci were reported to me by Dr. Charles A. Oliver. On the use of gonococcic vaccine "both cases showed some local reaction with marked recrudescence of joint lesions. The first improvement was probably more rapid than I have formerly seen, but of this I am uncertain."

I have recently treated a case of double metastatic gonorrheal iritis occurring in a negro of 23 years who had a gleet. In the right eye the anterior chamber was about one-quarter full of plastic lymph; in the left eye there was very little plastic lymph. The patient was admitted to the New York Eye and Ear Infirmary. Rest in bed and atropin were the only measures employed other than the vaccine. The initial injection was one of 2,500,000 followed in twelve hours by a similar dose; twenty-four hours later a dose of 5,000,000, which was repeated in twenty-four to forty-eight hours. Recovery occurred in about twelve days. Some of the plastic lymph was removed from the anterior chamber of the right eye. It did not show gonococci, nor were cultivations obtained on blood-agar. The discharge from the gleet showed gonococci.

From the evidence adduced it is very well proved that gonococcic vaccine is a valuable therapeutic agent in the treatment of the manifestations of chronic gonorrhea.

STREPTOCOCCIC VACCINE

Streptococcic vaccine is put on the market in 1 c.c. quantities, the strength of the preparation being indicated on the package. The dose recommended by Sir A. E. Wright is 10 to 20 millions, the minimum dose to be the initial dose, this to be increased according to the toleration of the patient. Injections to be intramuscular.

In 58 cases of erysipelas tabulated by Duncan,[3] seven patients were "cured;" in fifty the result was "satisfactory," and in one no result was obtained. This vaccine may be of value in cases of erysipelas affecting the eye.

C. R. Holmes has employed the vaccine in erysipelas. "Some cases were greatly modified, but in none of them was there any decided result."

STAPHYLOCOCCUS VACCINE

With the staphylococcus, as with almost all microorganisms, it is the opinion of clinicians that the vaccine made of the "autogenous" strain gives better results than vaccine made of a number of heterogenous strains combined (polyvalent).

It is well known that the staphylococcus is a factor in the production of the eczematous processes of the lids, conjunctiva and cornea of some abscesses of the lid of some forms of blepharitis marginalis, and of suppurations of the globe after traumatism of whatever kind.

The following cases of the use of staphylococcic vaccine have been reported:

Alexander Duane of New York reports a case of sluggish purulent infection of the eye. Hypodermic injections of a polyvalent vaccine of the *Staphylococcus aureus* were given with apparently good results. Six injections were given in seventeen days, begining with a dose of 240,000,000.

Frank C. Todd of Minneapolis reports one case of chronic hordeoli, with pustules on the face and eczema around the nostrils. The patient had been treated for this condition from time to time for five years. Hypodermic injections of an autogenic vaccine of *Staphylococcus aureus* were followed by complete recovery.

Charles A. Oliver of Philadelphia has employed autogenic vaccine of the *Staphylococcus albus* in cases of recurrent hordeoli, injecting in the corresponding arm and upper dorsal region with apparent good results.

H. Gradle of Chicago has treated a number of cases of eczematous conjunctivitis and keratitis, with eczema about the nares, with autogenic staphylococcus vaccine with very successful results, not only as regards recovery from the local disease but also in improvement of the general condition of the individuals.

COLEY'S TOXIN

Coley's toxin is in reality a bacterin or vaccine composed of a mixture of *Streptococcus pyogenes* and *Bacillus prodigiosus*.[4] The method of preparation is described in Coley's article.[5]

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[4] This form of treatment originated from the recorded fact (J. Bland-Sutton: Tumors, Innocent and Malignant, Ed. 4, p. 303) that inoperable sarcoma has been known to disappear after an attack of erysipelas. The prodigiosus element was incorporated after it was shown by Rogers that by growing the *Bacillus prodigiosus* with the streptococcus of erysipelas the virulence of the latter was increased.

[5] Coley: Boston Med. and Surg. Jour., Feb. 6, 1908.

The initial dose should be ¼ minim, diluted with a few drops of sterile water, hypodermically injected, remote from the tumor. After a few injections, if the reaction is not great, the toxins in the same dose may be injected into the growth. The reaction when the toxins are injected into the growth is greater than when it is injected remote from the growth. Coley states that "the dose should be gradually increased by ¼ minim when injected into the tumor, by ⅓ to ½ minim when injected outside the limits of the tumor, until the desired reaction is obtained. The best results are obtained by doses sufficiently large to produce moderately severe reactions, a temperature of 102 F. to 104, with or without chills." The dose is repeated when the temperature reaches the normal.

Coley states that carcinoma is not influenced by the treatment, and he has not had a recovery in melanotic sarcoma. He reports having treated 430 cases of inoperable sarcoma with the mixed toxins. In forty-seven cases the growth completely disappeared; in twenty-eight cases a period of from three to fifteen years has passed since the disappearance. The treatment has also been employed as a preventative to recurrence after operation, with apparent good results.

A number of brief reports of cases affecting the eye or orbit have been obtained.

W. E. Jack, Boston, Mass.: Sarcoma of orbit; toxins injected into the growth and into the arm. Local reaction occurred when the toxins were injected into the growth. Result negative.

George E. De Schweinitz, Philadelphia: Inoperable sarcoma affecting the antrum. Result "most unfavorable." Obliged to discontinue treatment.

Henry A. Brandoux, St. Paul, Minn.: Two cases, one of which resulted in a cure. The second case resulted in death after exenteration of the orbit and the subsequent removal of a recurrent growth on the inferior margin of the orbit.

Coley[6] mentions a personal report of R. Tilly of Chicago: "Adult male, aged 24; inoperable sarcoma of orbit which disappeared under three weeks' treatment with the serum."

J. E. Weeks, New York: Case of recurrent melanotic sarcoma of the orbital tissue in a man aged 72 years. After exenteration of the orbit, Coley's fluid was injected as a preventive to recurrence for three weeks and again after an interval of about three weeks for three weeks longer. The injections were given every third day. Metastasis, apparently in the liver, occurred three years later, causing death.

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[6] Coley: Am. Jour. Med. Sc., 1906, cxxxi, 375.

SERUMS

DIPHTHERIA ANTITOXIN

The great value of this serum is too well known to require further elaboration here. The initial dose is 1,500 to 6,000 units, according to the age of the patient and the severity of the infection. The diphtheria antitoxin globulins are employed in proportionate strength. The dose may be repeated in twelve hours if no improvement is noted; in twenty-four hours, if improvement is moderate. In ocular diphtheria two injections are frequently sufficient; should there be an arrest in the improvement, however, or should the improvement be very slow, a third or fourth injection may be given.

GONOCOCCIC SERUM

The serum of Rogers and Torrey is made by a number of manufacturers. It is obtained from the sheep some days after the injection of living gonococci into the peritoneal cavity.

The serum is usually injected into the loose subcutaneous tissue between the skin and deep fascia of the upper arm. Any other convenient place may be used. The dose is ordinarily 2.5 c.c., repeated every forty-eight hours. This general rule is modified by the general condition of the patient and the degree of reaction occasioned.

A number of cases of conjunctivitis have been treated with the serum, both by local application and by injection, with little or no benefit. With iritis the results have been very promising in the few cases treated by this method.

Dr. Arnold Knapp[7] reports the following case of gonorrheal iritis treated by Torrey's serum:

J. W., gonorrhea contracted two and a half years previously, metastases in joints, pericarditis and three attacks of iritis. The last three attacks treated with Torrey's antigonococcic serum. Iritis characterized by pain, fibrinous exudate, marked ciliary congestion; no adhesions. Symptoms aggravated in both attacks after second or third injections. Condition of eyes then rapidly improved, clearing in from two to three weeks from onset. Ten injections on each occasion.

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[7] Knapp, Arnold: Arch. Ophth., 1908, xxxvii, 231.

As far as one case could show, the serum is a remedy of value and deserves further trial. Thus far its action and mode of use are not understood.

Dr. Torrey, in discussing the above case, stated that the inflammation and exudate became more marked after the first injections. This corresponds to the action of the serum in gonorrheal arthritis.

In a personal communication Dr. Arnold Knapp reports having treated three other cases, with cure in two and an indefinite result in one.

Dr. C. W. Cutler[8] has employed serum treatment in a few cases of gonorrheal ophthalmia. He injected it hypodermically in the case of two infants and also dropped it in the eyes without any reaction or pain. Both recovered. One was a moderately severe case and seemed to improve after each injection. The routine treatment was continued, however.

Dr. George S. Derby of Boston, in a personal communication, reports one case of acute gonorrheal ophthalmia in which the Rogers-Torrey serum was employed. The result was negative.

Dr. R. H. Herbst[9] of Chicago gives the following results of the treatment of general gonorrheal infection which will be of value here as indicating what may be expected by use of this serum. Fifty-two patients, including almost every form of gonococcus infection, were injected with this serum. Of this number, 45 were treated in the clinic at Rush Medical College; 7 were private patients. They were divided into six groups as follows:

1. Acute gonococcus infection of the anterior or anterior and posterior urethra, with or without infection of the prostate and seminal vesicles.
2. Subacute gonorrhea of the anterior or anterior and posterior urethra.
3. Chronic gonorrhea of the anterior or anterior and posterior urethra.
4. Acute gonococcus infection of the epididymis.
5. Acute infection of the joints.
6. Chronic gonorrheal joints.

In the first group, namely, the acute gonococcus infection of the anterior and posterior urethra, seventeen individuals were injected. These patients were given the maximum dose, 6 c.c., as frequently as the reaction would allow, without any change in the discharge from the urethra or other symptoms.

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[8] Cutler, C. W.: Tr. Ophth. Section New York Acad. Med., Feb. 19, 1906; Arch. Ophth., 1906, xxxv, 409.

[9] Herbst, Robert H.: Serum Treatment of Gonorrhea with Report of Cases, The Journal A. M. A., May 23, 1908, l, 1678.

In Group 2, subacute gonorrhea of the anterior urethra or anterior and posterior urethra, nine patients were injected. Eight of these did not show any improvement after repeated injections, one cleared up after the third injection.

In Group 3, chronic gonorrhea of the anterior and posterior urethra, eleven patients were injected. Seven did not show any improvement; one cleared up after eight injections given during a period of four weeks, one after six injections given during a period of three weeks, and two passed clear urine after four injections given during two weeks.

In Group 4, acute gonococcus infection of the epididymis, four were injected. Three did not improve so quickly as usually seen with local treatment. In one case the swelling subsided in two weeks without the return of the discharge from the urethra; this patient received six injections of 4 c.c. each.

In Group 5, acute gonococcus infection of joints, four were injected. Two of them were aspirated and the gonococcus demonstrated. One patient is under treatment at the present time; three did not show much change.

Group 6, chronic gonorrhea of joints, included seven patients. All improved promptly after the first few injections.

The conclusions to be drawn from the above are clear. First, the serum has absolutely no effect on acute gonorrheal infections; second, its value in subacute and chronic cases is very doubtful, although there were a few isolated cases in which the results were somewhat better than we see with local treatment. Third, the value of this serum in the treatment of chronic gonorrheal joints is without question.

STREPTOCOCCIC SERUM

The streptococcus pyogenes is usually employed in the preparation of this serum. The serum is put on the market in hermetically sealed glass bulbs, each containing 10 c.c. The initial dose is 10 to 20 c.c. repeated in twenty-four hours if improvement is not marked.

My thanks are due to those named below for the following brief reports of cases treated with this serum.

Charles S. Bull, New York: Case of deep orbital streptococcic infection. Subconjunctival injection of antostreptococcic serum prepared by the Board of Health of the city of New York. The result was doubtful. There was an "apparent diminution of infiltration and shortening of the period of duration of the acute symptoms."

B. A. Ellis Los Angeles: Has employed antisterptococcic serum (Parke, Davis & Co.) in the streptococcic eye infections with "excellent results."

R. D. Gibson, Youngstown, O.: Has employed antistreptococcic serum (Stearns & Co.) in streptococcic eye infections by subcutaneous injections. Results negative.

Allen Greenwood, Boston: Has employed Marmorek's serum injected subcutaneously in large dose. Results were good in cases of erysipelas of the eyelids.

E. R. Lewis, Dubuque, Iowa: Has employed antistreptococcic serum (Parke, Davis & Co.) "in probably a hundred or more cases" by deep intramuscular injection "of from 10 to 30 cc. at various intervals." Results negative.

F. T. Rogers, Providence, R. I.: Has used antistreptococcic serum (Parke, Davis & Co.) by deep injection. Results negative.

Frank C. Todd, Minneapolis: Has employed the antistreptococcic serum by hypodermic injection. In one case of septicemia due to streptococci, recovery took place, owing, Dr. Todd thinks, to the serum. In other cases the result was negative.

D. N. Dennis, Erie, Pa.: Antistreptococcic serum (Parke, Davis & Co.) employed hypodermically in a case of erysilepas and in corneal ulcer due to streptococci. Results very good indeed; the improvement was immediate.

N. L. Wilson, Elizabeth, N. J.: Has employed the antistreptococcic serum (Parke, Davis & Co.) in a few cases, injecting hypodermically. Results "not good."

It will be noted that the results obtained by use of the serum have been very variable.

TETANUS ANTITOXIN SERUM

Tetanus antitoxin was first introduced by Behring and Kitasato. It is produced in the same manner as the diphtheria antitoxin and is standardized. This serum is manufactured by a number of municipalities and corporations in the United States and is reliable.

For immunizing purposes the dose is 1,500 units of the antitetanus serum injected intravenously preferably. Subcutaneous injections may be made, but are less effective (Park). For treatment 3,000 to 10,000 units should be injected intravenously to begin with, according to the severity of the case, and repeated every eight to twelve hours until the symptoms abate. The injections should be made at the earliest possible moment, as the degree of efficacy is in inverse proportion to the duration of the infection.

While of comparatively little value in ophthamology because of the rarity of the cases, some cases have been reported.

Bert Ellis, Los Angeles: Has employed the antitetanic serum in three cases, injecting the serum hypodermically. There were two recoveries. Further particulars fail.

E. R. Lewis, Dubuque, Iowa: One severe case of ten days' duration. Parke Davis & Co. antitetanic serum employed. Deep injections at frequent intervals and varying dosage. Result, recovery. Lewis is favorably impressed with the serum.

E. J. Bernstein, Kalamazoo, Mich.: Has employed the antitetanic serum to control infection (immunize) in nine cases of wounds of the eye in which tetanus infection was suspected. Development of tetanus did not take place.

That this serum is of much value in the early treatment of tetanus is conceded by all who have used or studied it.

TYPHOID AND MENINGITIS ANTITOXINS

The serum of Chantemesse[10] (typhoid antitoxin) need not be considered in relation to the eye.

Flexner's serum (meningitis antitoxin) which has proved so beneficial in epidemic cerebrospinal meningitis, will probably never be of value in ocular therapeutics except in connection with its use for the systemic disease. The relatively infrequent affections of the eye due to the meningococcus will mend as the epidemic cerebrospinal disease improves under the use of the serum.

DEUTSCHMANN'S SERUM

Deutschmann's serum[11] is obtained from animals that have been fed on living yeast cells in large quantities. The serum as found on the market is prepared in two forms; one, the true Deutschmann serum with some trikresol added to prevent decomposition, marked "Deutschmann's serum," and one in which the active principle of the serum is precipitated by a method devised by Dr. Enoch of the Reute-Enoch Laboratory, Hamburg, then redissolved in water and designated "Deutschmann's Serum E." Both preparations are put up in bottles of 2 c.c. The latter is about twice the concentration of the former.

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[10] Chantemesse: L'Hyg. gén. et Appliquée, October, 1907.
[11] Deutschmann: München. med. Wchnschr., 1907, No. 19.

Deutschmann asserts that his serum is efficient as an adjuvant against pneumococcic, streptococcic, and staphylococcic infections.

The dose of the serum is to be governed by the effect on the pathologic process; in adults, 2, 4, 6, or even 8 c.c. may be injected twice, thrice, or even more times weekly. The injections are intramuscular, either in the chest or in the abdominal walls.

The following cases of its use have come to my notice:

H. Gifford of Omaha, Neb., reports one case of severe infection of the eye. Deutschmann's serum was injected. Results negative (further particulars fail).

Arnold Knapp of New York employed Deutschmann's serum in one case. Result negative.

This serum is of doubtful value.

CYTOGENIC SERUMS

Cytogenic serums were among the first produced. Von Dungern[12] suggested the possibility of using an epitheliolysin for the destruction of epithelial cancer-cells that were left in the body after the work of the surgeon. These serums all possess hemolytic and hemagglutinative properties and are specific against the cells of the organs from which the inoculation was made.

Working on the principle that "the accepted biologic principle at the present time is that the nucleus is the most important morphologic and physiologic portion of the cell, and hence it follows that its chemical constituents must be those most necessary for nutrition," S. P. Beebe[13] isolated nucleoproteids from various tissues and produced antiserums by their injections into the peritoneal cavity of alien animals, hoping to obtain specific serums. Active serums were produced.

At the suggestion of Dr. John Rogers, Beebe[14] endeavored to apply these methods to the thyroid, in the treatment of exophthalmic goiter. Thyroid glands from two human subjects who had died of exophthalmic goiter were first used. The nucleoproteids and the thyreoglobins were extracted from the thyroid glands by Ostwald's method.[15] A mixture of the two proteids was injected into rabbits, and the serum thus obtained was believed to possess both cytolytic and antitoxic properties.

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[12] Von Dungern: München. med. Wchnschr., 1899, xlvi, 1228.

[13] Beebe, S. P.: Jour. Exper. Med., 1905, p. 733.

[14] Beebe, S. P.: Preparation of a Serum for the Treatment of Exophthalmic Goiter, The Journal A. M. A., Feb. 17, 1906, xlvi, 484.

[15] Ostwald: Virchows Arch. f. path. Anat., 1902, clxix.

As the difficulties attending the getting of the thyroid gland in cases of exophthalmic goiter would make it impossible to produce sufficient serum to place it on the market, normal human thyroid glands, obtained at autopsy, were employed. The nucleoproteids obtained from this source produced a serum less potent than the first, but sufficiently active. It was found that the best serum was obtained from the sheep.

Since it is possible to obtain serums from diseased glands in small amounts, which are more active than those obtained from normal glands, Rogers[16] proposes that the different serums be designated as "pathologic" and "normal" serums, respectively. Rogers,[17] referring to the results of the therapeutic use of thyroid cytoserum, gives the following statistics:

> Four hundred and eighty cases representing all stages and varieties of thyroidal diseases have thus come under my personal observation for a greater or less length of time, and Dr. Beebe has records of about as many more who have been treated with his laboratory products by many other physicians. In my series approximately 15 per cent. have been cured of all traces of their disease; some 10 per cent. have no abnormal subjective symptoms but still retain signs generally of goiter—less often of exophthalmus or other indication of their disorder noticeable to the trained observer; about 50 per cent. have improved to a greater or less extent, which usually means that after a month or two of treatment, with alleviation of symptoms, the patients have passed from observation and may at present be better or worse than when last seen; about 17 per cent. have failed to show any improvement and 8 per cent. have died from the natural progress of their disorder.

The cytoserum of carcinoma[18] has not been used as yet in carcinoma of the eye.

SYPHILITIC SERUM

Since the application of the method known as complement deviation[19] by Wassermann, Neisser and Bruck[20] to the diagnosis of syphilis and the discovery of the so-called Wassermann reaction, a method for the diagnosis of syphilis has been devloped which is undoubtedly of value to ophthalmologists in clearing up the etiology of doubtful eye lesions. In regard to its value Butler,[21] after an exhaustive review of the literature on the subject, sums up as follows:

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[16] Rogers, John: The Treatment of Thyroidism by a Specific Serum, The Journal A. M. A., Sept. 1, 1906, xlvii, 655.

[17] Rogers: Ann. Surg., December, 1909.

[18] Strauss, S.: The Serum Treatment of Carcinoma, The Journal A. M. A., Oct. 31, 1908, li, 1488.

[19] Bordet and Gengou: Ann. de l'Inst. Pasteur, 1901, xv, 289.

[20] Wassermann, Neisser and Bruck: Deutsch. med. Wchnschr., 1906, xxxii, 745.

> The serum [Wassermann] reation for syphilis is specific. It is found positive in from 90 to 85 per cent. of all cases with syphilitic manifestations. . . . in 50 to 60 per cent. of latent cases . . . in from 70 to 80 per cent. of parasyphilitic diseases.

A negative reaction does not positively exclude syphilis.

The Noguchi tests[22] based on the increased globulin content of syphilitic serum has proven to be reliable, and is a relatively simple means of diagnosing syphilis.

A comparison of the results by the Wassermann and the Noguchi tests, made by Noguchi, shows the latter to be of equal if not of greater reliability.

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[21] Butler, William J.: Serum Diagnosis of Syphilis, THE JOURNAL A. M. A., Sept. 5, 1908, li, 824.

[22] Noguchi, H.: Jour. Exper. Med., January, 1909.

MEMORANDA

THE DANGER OF SYMPATHETIC OPHTHALMIA FROM THE USE OF THE CAUTERY IN TREATING IRIS-PROLAPSE

OTHER METHODS OF TREATMENT *

H. GIFFORD, M.D.
OMAHA

In 1897 Trousseau[1] reported three cases of sympathetic ophthalmia (two of his own and one of Kalt's) following the use of the galvanocautery in treating prolapse of the iris; and in the same year[2] I felt impelled by my own experience to second the warning given by Trousseau. Since then I have happened to notice the histories of seven cases of sympathetic ophthalmia in which the authors mentioned incidentally that a wound or an iris prolapse had been cauterized a suitable length of time before the outbreak of the disease in the second eye. These cases were reported by the following authors: Alexander,[3] Darier,[4] Alberti,[5] Dimmer,[6] and Fuchs,[7] who each report a case occurring after cauterization of an iris prolapse or a cystoïd scar; and Cohn[8] mentions two cases from the clinic of Silex in which a wound was cauterized before the sympathetic ophthalmia broke out. Finally, Trousseau[9] again returns to the subject with the report of two additional cases of the sort and a renewal of his warning against the use of the cautery.

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* This paper has been accepted by the Executive Committee of the Section on Ophthalmology of the American Medical Association, to be presented at the St. Louis Session, June 7-10, 1910. Publication rights reserved by the American Medical Association.

1. Trousseau: Recueil d'Ophth., 1897, p. 249.
2. Gifford: Ophth. Rec., 1897, p. 673.
3. Alexander: Ophth. Klin., April 5, 1900.
4. Darier: Ophth. Klin., Aug. 5, 1900.
5. Alberti: Beitr. z. Augenh., v, 743.
6. Dimmer: Ztschr. f. Augenh., August, 1901.
7. Fuchs: Arch. f. Ophth., lxx, 469.
8. Cohn: Ztschr. f. Augenh., January, 1905.
9. Trousseau: Arch. d'opht., November, 1909.

Trousseau does not attempt to explain how the cautery favors the occurrence of sympathetic ophthalmia, but in following the subject for a number of years I have noted two communications which throw some light on the subject. Franz[10] has found as the result of experimentation that the sloughs produced by the use of the actual cautery in the abdominal cavity decidedly favor the occurrence of infection; and La Garde[11] discovered that, when the tissues are burned, tetanus can be produced by quantities of the tetanus bacillus which are quite harmless when introduced into incised wounds.

In the early days of my practice I used to regard the charred and dead tissue left by the cautery as an efficient protection against infection or reinfection, but for many years I have taken the opposite view, and when I have found it desirable to use the cautery, as in some cases of trachoma, I have carefully scraped away all the dead tissue and I am sure that this has been followed by less irritation than when the sloughs have been allowed to remain; and in some corneal ulcers after using the cautery I scrape away the slough and apply trichloracetic acid to prevent reinfection. Whether the influence of the cautery slough in favoring infection is due to its forming a favorable culture medium or whether it depends on the nature of the surface left when the slough separates, I cannot at present say; but that such an influence exists and that it should make us cautious in the use of the cautery for iris prolapse is, I think, undoubted. For certain prolapses, however, when they are so small and old that they cannot be seized and cleanly excised, the cautery is so convenient an agent of destruction that if it could be used safely it would be highly desirable to retain it in favor; and I believe that if the burnt and dead tissue be scraped away and the raw surface covered at once with a conjunctival flap all danger from its use can be avoided.

USE OF TRICHLORACETIC ACID

The use of a conjunctival flap, however, necessitates an operation which, slight as it is, we like to avoid if possible; and with this in view I have experimented for a year or so with the treatment of prolapses by trichloracetic acid.

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[10] Franz: Abst. in Centralbl. f. Chir., 31, 1902.

[11] La Garde: The Journal A. M. A., April 18, 1903.

This agent, the introduction of which into ophthalmology we owe to Bulson, produces a slight eschar which apparently offers a very unfavorable culture medium for germs. The reaction following its use, whether in the eye or the nose, is practically *nil;* and a few applications to an iris prolapse cause the latter to disappear or to be covered with a thin layer of connective tissue which, it would seem, must prevent the penetration of germs into the eye. I have used this agent with the best of results in cases in which after a large destructive corneal ulcer a considerable area of iris tissue has been left exposed. In cases of this kind I have never been able to get a conjunctival flap to adhere to the iris tissue, but by the use of the trichloracetic acid I have produced smooth white non-irritable scars; and in one case in particular, in which a large prolapse in the upper quadrant of the cornea was already infected and the eye apparently in a desperate condition, I am sure that the acid was the only thing that saved it from destruction.

Incidentally I may remark that in all cases of infected wounds of the eye I apply the trichloracetic acid vigorously for several days in succession, and in this way have in some cases saved the eye when at first the outlook seemed hopeless. I regret to report, however, that my confidence in the absolute security which I believed this acid conferred on eyes with iris prolapse has been shaken by the following case:

History.—In the Fall of 1908 I extracted, with a hook, a tough membraneous cataract from the left eye of a woman, aged about 50. A moderate amount of vitreous came with it; enough to interfere with a perfect reposition of the iris. The healing was smooth but an iris prolapse rather more than 1/16 inch in diameter developed at the inner angle of the wound. To this I applied trichloracetic acid four or five times, at intervals of three or four days, with the result that it disappeared entirely, leaving a smooth flat white surface almost indistinguishable from the other end of the scar. The patient left the city several weeks later with the eye free from irritation and possessing V. = 20/50 plus. The other eye was perfect, the extraction having been done largely for cosmetic purposes.

Subsequent History.—In the following September the woman returned, stating that some weeks after I had last seen her, that is, two months or more after the operation, the operated eye had become inflamed and a few weeks later the right eye followed suit; and in spite of treatment by a very competent oculist the vision of both eyes had been so much reduced that she could barely find her way about. I found the pupil of the left eye drawn high up and closed, V. = light, while in the

right eye the pupil was secluded and nearly occluded, V. = fingers at four feet. Both eyes were practically free from irritation and there was no sign of the former prolapse in the operated eye. An iridotomy has restored useful vision to the left eye, but when in January, 1910, after a prophylactic course of moderate doses of salicylate, I performed an iridectomy on the apparently quiet right eye, the pupil promptly closed up with exudate.

This case is such an unusual one that I am not sure that I ought to place any blame on the trichloracetic acid; but I feel that I ought to mention it as part of the evidence before the jury, and the next iris prolapse which I treat I shall, after the use of the cautery or trichloracetic acid and scraping, protect with a conjunctival flap if it is possible; but if it is one of the large prolapses within the corneal area I shall treat it with trichloracetic acid.

In view of the large number of prolapses which we see that never seem to cause any irritation nor do any harm the question may well be asked why bother any of them. The case is parallel to the problem of prophylactic enucleation. We know that the majority of injured sightless eyes do not cause sympathetic ophthalmia, but some of them do; and so do some iris prolapses. I have seen sympathetic ophthalmia in at least six cases of untreated iris prolapse from comparatively slight wounds.

With regard to fresh traumatic prolapses that cannot be replaced we can all agree that there is no treatment like a clean incision, but in deciding whether or not a prolapse can be replaced one should not forget the method of indirect reposition advocated by Dunn[12] of Richmond, Va., and after him by Jameson.[13] The principle of Dunn's method is that, instead of trying to push the prolapse back through the original wound, it is better to make another opening at a distant point of the corneal margin and, with a spatula introduced through this, draw back the iris from the original wound. I can recommend this method heartily in fresh cases, having used it in one case with perfect success.

CONCLUSIONS

My own conclusions on this subject may be summed up as follows:

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[12] Dunn: Arch. Ophth., September, 1907.

[13] Jameson: Arch. Ophth., January, 1909.

1. Fresh non-infected prolapses should be replaced, if possible; preferably by Dunn's method.

2. Prolapses which cannot be cleanly excised should, if possible, be cauterized and the area scraped and protected at once by a conjunctival flap.

3. On account of the danger of sympathetic ophthalmia no prolapse should be treated by a hot metal cautery, unless a protecting conjunctival flap can be made to adhere to the area cauterized; it is probably safer to let the prolapse alone.

4. In some cases of large corneal prolapses to which conjunctival flaps can be made to adhere with difficulty or not at all, the use of trichloracetic acid (and probably of various other chemicals) produces a firm non-irritable scar. Whether this method is entirely devoid of danger remains to be seen.

Brandies Building.

MEMORANDA

OPHTHALMIA NODOSO OR CATERPILLAR-HAIR OPHTHALMIA

WITH REPORT OF A CASE *

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By ophthalmia nodosa is understood an affection of the eye caused by the entrance into the tissues of the eyeball of the hair of certain varieties of caterpillar. It was first described by Pagenstecher[1] in 1883 as "caterpillar-hair ophthalmia," later by Wagenmann[2] as "pseudotuberculosis," and by Saemisch as "ophthalmia nodosa." It shows a tendency to form tubercle-like structure, often showing nodules appearing singly or in crops, progressing mostly with exacerbation and remissions. The patient does not always give a history of caterpillar contact, the diagnosis being made with the aid of the microscope.

We are indebted for studies on this subject to Baas,[3] Wagenmann,[2] Hillemann,[4] Kruger,[5] Lawford,[6] Stargardt,[7] de Schweinitz and Shumway,[8] Teutschlaender[9] and others, and for an analysis of the literature to Ginsberg,[10] Greef,[11] and Parsons.[12]

The disease is most common among those who work in the woods and fields. In most cases, the caterpillar falls or is thrown into the eye of the patient, or more rarely the infection occurs through free hairs, as in the case here reported. Ralzeburg pointed out the varying susceptibility of different persons, and Teutschlaender[9] proved by experiments on himself that the skin varies as to susceptibility according to its thickness. He obtained a marked reaction on the thin skin of his forearm, but practically none from the thicker skin of the

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finger, the same caterpillar being used in both tests. The hairs have been demonstrated in the conjunctiva, episclera, sclera, cornea, iris and in one case in the choroid.

As a rule, the first symptoms appear soon after the trauma, although in exceptional cases no symptoms appear until the nodules are present. When the cornea is involved the initial symptoms are often most severe. They consist of the sensation of a foreign body in the eye, itching or burning, with lacrimation and photophobia, all being heightened by rubbing. These symptoms are followed by swelling of the lid, pericorneal injection and edema. There is usually loss of corneal epithelium, either through wounding by the caterpillar, or through the rubbing by the patient. The initial stage continues as long as the hairs cause irritation, either mechanically or chemically, or until the hairs penetrate the tissues and become encapsulated, which occurs from the fourth to the eighth day (Teutschlaender[9]). At the end of the second week or the beginning of the third, the first nodule or nodules appear, thus ushering in the typical stage of ophthalmia nodosa. Should the hairs be eliminated the disease may be aborted without developing a nodular formation.

Karsten in 1848, as quoted by Leydig, demonstrated the fact that the irritating variety of caterpillar (*Saturna*) has skin glands which discharge directly into the wide canal of the chitin integument, which canal passes into the base of the hair, while the non-irritating varieties (*Vanessa, Acraca, Argymus*) do not have these glands. In 1855, Leydig confirmed the work of Karsten and demonstrated the presence of the gland in the *Bombyx rubi* (*Barenraupe*).

Other explanations than the Karsten-Leydig medullary poison theory have been advanced to explain the peculiar symptoms that follow the entrance of hairs of certain caterpillars into the tissues, among which are the *Gossen-Fabre* varnish theory, namely, that the poison is a by-product of the organic metabolism of the caterpillar and adheres to the outside as pollution; and the Stargardt[7] resorption theory, namely, that the toxin is a product resulting from decomposition of the chitin which the absorption of the hair brings about. The possibility of bacterial infection as the exciting cause has been disproved by negative results obtained by Stargardt,[7] by de Schweinitz and Shumway,[8] who transplanted a piece of conjunctiva rich in nodules into the anterior chamber of a rabbit; by the results of the tuberculin injections of Kruger[5] and Becker;[13] and also by the microscopic examination of the excised material by Wagenmann,[2] Becker,[13] Hillemann,[4] Hanke,[14] Bostrom,[15] de Schweinitz and Shumway,[8] Stargardt,[7] and Teutschlaender.[9] The offending hair appears to be sterile (possibly owing to the disinfecting action of the contained formic acid as suggested by Mitschenkoff) and the symptom-complex cannot be explained on the theory of an accompanying bacterial infection.

The caterpillar hairs are more or less pointed, tubular structures, which are either needle-like and rigid or worm-like and flexible. Their surface is either smooth or covered with barbs or spinules. They are composed of a chitinish substance, which surrounds the medullary canal. Into this canal the secretion of the gland is emptied. The hairs are very numerous and easily detached. Owing to the fact that as the barbs all point upward the hair must enter the tissues base foremost.

Formic acid, which plays such an important part in insect poison, has been proved to be present in the gland secretion (Fabre). When the hair enters the tissues more or less toxin escapes from the medullary canal, and the initial symptoms are produced. The course is chronic—may cover months or years. According to Teutschlaender,[9] the latent period, interrupted by acute exacerbations, are so characteristic of the disease that he agrees with Meixner[16] that it is almost pathognomonic for ophthalmia nodosa. Recurrences have been reported at periods of time varying from four days (Natanson's[17] case) to over three years (Stargardt's[7] case). The patient in the later case had the first recurrence one month after the time of infection, the third attack three years later, and the fourth after another month. According to different theories, the recurrences may be owing to a new infection; the wandering of a non-encapsulated hair; or to chemical action. Hillemann,[4] Lawford[6] and Teutschlaender[9] all agree that from an analysis of the clinical observations it would seem that in addition to the mechanical irritant another agent must be present, which gives to the clinical history its peculiarity, and they believe that the idea of a chemical toxic agent best explains not only the clinical manifestations of the initial attack, but is the cause of the recurrent attacks as well. The details of the process as given by Teutschlaender[9] are as follows:

The initial inflammation subsides, some of the hairs being eliminated, while those remaining behind have their mechanico-chemical irritation hindered through the process of infiltration and encapsulation. But so long as the foreign body or its poisonous substance have not been absorbed or eliminated the process is not permanently stopped. Either there is an intensification of the poison, or else the protection of the tissue is weakened. The tissue changes, which during the inflammatory period caused a halt in the work of the etiologic factor, undergo a certain metamorphosis during the latent period. The edema and cell infiltration disappear and the protection is lessened. At the same time changes are taking place in the hair. The chitin-layer is being absorbed and larger openings in the medullary canal allow the poison to escape and the chemical agents to accumulate at the inner part of the nodule. When a sufficient amount has accumulated, or the protection is weakened or gone, an irritation is set up and the reaction appears, resulting in a recurrence of the initial process. This cycle goes on until the poison has all been carried off, when the hair remains in the tissue as an unirritating foreign body.

While the clinical picture of ophthalmia nodosa is characteristic, the anatomic changes are not. The first change is an intensely active hyperemia soon associated with round-celled infiltration which appears especially in the direction of the foreign body and is accompanied by more or less edema. Those hairs which are superficially situated and circumscribed by the cell infiltration may be pushed out when healing follows. The mechanico-chemical action calls forth a cell diapedesis and proliferation until a sufficiently protecting wall is built up. While in the early stage of the nodule formation round-celled leucocytes are the predominating element, later epithelioid and giant cells are added.

The conjunctiva is the most frequent site of infection and it is here that the typical nodules so suggestive of tubercle are formed. The number of nodules varies greatly—in one case twenty-seven were demonstrated (de Schweinitz and Shumway[8]). They are grayish-yellow in color and between them there is marked congestion of the conjunctival and episcleral vessels.

In the cornea, the pericorneal injection appears almost immediately, and on the third day the infiltration is noticeable. While the areas of infiltration are well defined, they are not elevated as is the case in the conjunctiva and iris. This is owing to the fact that the cornea is non-vascular (Teutschlaender[9]).

The iris is far more frequently affected than the cornea. The hair perforates the cornea either through the force of the fall of the caterpillar or through the rubbing of the eye by the patient. With one part still sticking in the cornea, the hair may bridge the anterior chamber and by means of its spinules become attached to the iris, which by its movements in dilating and contracting may draw the hair away from the cornea. At the point of entrance of the hair into the iris hyperemia and swelling occur, followed by cell infiltration, resulting in the formation of a nodule. In most cases the reaction is not severe enough to jeopardize the vision, although in one reported case an iridochorioiditis plastica followed with blocking of the pupil, and in another the eyeball shrunk, resulting in phthisis bulbi.

One patient (Kruger's), as observed by Reis,[18] twelve years after the occurrence of the infection, showed seven scars in the conjunctiva, one nodule in the episclera (from which a well-preserved hair was extracted), an opacity in the cornea (from which a hair was removed), and in the chorioid a Y-shaped streak of chorioidal degeneration bordered with pigment with a greenish reflex at one extremity, which Reis thought probably was a hair. The following report is of my case:

Patient.—H. S., male, aged 33, first came under observation in April, 1906, with the history of having had recurrent attacks of very severe pain and redness in the right eye at intervals of about 30 days, from October, 1905. The first attack came on with excessive lacrimation, severe pain and some swelling. After 3 or 4 days the more severe symptoms disappeared, though the eye remained irritable throughout the entire course of the affection. At this time all the history I was able to obtain was negative. Later, however, after 3 months' unsuccessful treatment, when asked if he had had anything to do with caterpillars, he replied: "Last October the caterpillars were so thick in our apple trees we had to burn them out." On closer inquiry, it was found that his first attack came on immediately after the trees had been freed of the caterpillars, but the patient himself did not associate in any way the work done on the trees with the disturbance in his eye. There was no history of having been struck in the eye, so the infection must have been from the free hairs.

Number.	Reported by	Date.	Anamnesis of Caterpillar.	Species.	Hair Demonstrated.	Tissues Affected.	Nodules.	Time Between Accident a First Consulon.	Recurrences.	Month of Injury.
1	Pagenstecher[1]....	1883	No......	Not determined.	Yes	Conjunctiva and iris	26 nodules............	5-6 months.	4 weeks.......	August or September.
2	Bass[3]............	1888	Yes.....	*Cnethocampo processionea.*	Yes.	Conjunctiva.........	None..................	Few days.	None	July.
3	Bass[3]............	......	Yes.....	*Cnethocampo processionea.*	No..	Conjunctiva.........	None..................	Few days.	None..........	July.
4	Weiss[19]..........	1889	Yes.....	*Bombyx pini*.....	Yes.	Iris.................	Several...............	6 months.	4 months.	June.
5	Wagenmann[2]	1890	Yes.....	*Bombyx pini*.....	Yes.	Conjunctiva and iris.	Conjunctiva, 2-3 nodules; iris, 2 nodules.	4 months.	None..........	September.
6	E. Kruger[5].......	1891 and 1892	Yes.....	*Bombyx rubi*.....	Yes.	Cornea, iris, conjunctiva.	Cornea, several; iris, several; conjunctiva, 12.	4 months.	6 months.	September.
7	E. Kruger[5]........	......	No..	*Bombyx rubi*.....	Yes.	Conjunctiva and iris.	Not stated............	2 months.	None..........	September.
8	E. Kruger[5]........	......	Yes.....	*Bombyx rubi*.....	Yes.	Conjunctiva, iris, cornea.	Conjunctiva, many; iris, 1 nodule; cornea, 1 hair.	6 months.	None..........	September.
9	Becker[13]	1892	Yes.....	*Bombyx rubi* or *Bombyx pini.*	Yes.	Conjunctiva and iris.	Conjunctiva, many nodules; iris, several.	3 months.	None..........	September or October.
10	Hillemann[4].......	1894	Yes.....	*Bombyx rubi*, probably.	Yes.	Conjunctiva, subconjunctiva, cornea and iris.	Conjunctiva, 3 nodules; subconjunctiva, 3 nodules; iris, 2 nodules.	5 months.	None..........	August.
11	Hummelsheim[19]..	1894	Yes.....	Not determined.	Yes.	Conjunctiva, iris and cornea.	Conjunctiva, 14 nodules; iris, 3 nodules.	3-4 weeks.	6 weeks.......	October.
12	Störmann[20]	1894	Yes.....	Not determined.	Not stated.	Conjunctiva and iris.	Several...............	Same day.	None..........	Not stated.
13	Elsching[21]	1895	Yes.....	*Cnethocampo processionea*, probably.	Yes.	Conjunctiva and cornea.	Cornea, several vesicles containing hair.	4 hours...	None..........	June.
14	J. B. Lawford[6]...	1895	Yes.....	*Bombyx rubi*.....	Yes.	Conjunctiva.........	Several.	2 weeks...	4 months.	September.
15	Hanke[14]..........	1896	Yes.....	*Bombyx rubi*.....	Yes.	Conjunctiva and cornea..............	2 in lower fornix, several on bulbar conjunctiva.	Several days.	Recurred in 10 days; again in 2 weeks.	October.
16	Boström[15]........	1897	No..	Not determined.	Yes	Cornea, scleral margin.	Limbus, 1 large nodule.	2 weeks...	None..........	Not stated.
17	Vossius[22].........	1897	No..	Not determined.	Yes.	Sclera................	1 large nodule.........	Not stated.	None..........	Not stated.
18	Knapp, Geo.[23*]...	1897	Yes.....	Not determined.	Yes.	Episclera, iris and cornea.	Iris, 1 nodule; episclera, 3 nodules;	Several days.	Repeated attacks for a	June.

19	Knapp, Geo[23]		No.	Not determined.	Yes.	Ocular conjunctiva.	3 nodules	2 weeks		Septe ber.
20	Knapp, Geo[23]		Yes.	Not determined.	Yes.	Ocular conjunctiva and cornea.	Conjunctiva, 4 hairs; cornea, 2 hairs.	2 days	None	September.
21	Colburn[24]	1897	Not stated.	Not determinad.	Yes.	Conjunctiva, cornea and anterior chamber.	Conjunctiva, 1 hair; cornea, 1 hair; anterior chamber, 1 hair.	Not stated.	None	Not stated.
22	Nathanson[17]	1897	Yes.	Not determined.	No.	Cornea and conjunctiva.	Conjunctiva, 7 nodules; cornea, vesicles.	1 day	Recurred in 4 days; again in 10 days.	July.
23	Bayer[25]	1900	Yes	Not determined.	Yes.	Cornea and iris	Cornea, 3 nodules; iris, several.	Some days.	None	Not stated.
24	Reis, W.[19]	1900	No	Not determined.	Yes.	Conjunctiva, cornea, iris, episclera and sclera.	14 nodules; 3 in iris.	6 weeks	1 week	July.
25	Meixner[16]	1901	Yes	Not determined.	Yes.	Conjunctiva, bulbi and iris	Several nodules	40 days	Recurred	September.
26	Denig[26]	1901	Yes	Spinning *Bombycina* (*Orgyia pudibunda.*)	Yes.	Conjunctiva	Several vesicles	1 month	None	July.
27	Stocké[27]	1902	Yes	Not determined.	No.	Conjunctiva	1 pea-sized vesicle	1 or 2 days.	None	Not stated.
28	Reis, W.[18]*	1902	Yes.	*Bombyx rubi*	Yes.	Conjunctiva, iris, cornea, episclera, chorioid.	Episclera, 1 nodule; conjunctiva, 7 nodules; cornea, 1 hair; chorioid, 1 hair.			
29	Stargardt[7]	1903	Yes.	Not determined.	Yes.	Conjunctiva, iris, sclera and cornea.	Conjunctiva, many nodules; cornea, hair.	2 months	1 month; 1 year; 1 month later.	May.
30	Stargardt[7]	1903	No.	Not determined.	Yes.	Iris and cornea	Iris, 1 nodule	5-6 weeks.	10 days	February.
31	Stargardt[7]		Yes.	Not determined.	Yes.	Cornea.	Cornea, hair; no nodules.	Several days.	None	August.
32	Stargardt[7]		Yes.	Not determined.	Yes.	Cornea.	Cornea, hair	2 days	None	August.
33	de Schweinitz and Shumway[8]	1904	No.	*Spilosoma Virginica* (*Bombyx*).	Yes.	Conjunctiva	27 nodules.	Few days.	None	July.
34	Valude[28]	1904	Yes.	Not determined.	Yes.	Cornea.	Several.	3 months	None	December.
35	Solva[29]	1905	Yes.	Not determined.	No.	Cornea and iris	Cornea, yellowish ulcers.	Not stated.	4 months	Not stated.
36	Teutschlaender[9]	1908	Yes.	*Bombyx rubi*	Yes.	Iris and conjunctiva.	Conjunctiva, many nodules; iris, several.	2½ months.	5 weeks	September.
37	Marlow[30]	1910	Yes.	Not determined.	Yes.	Conjunctiva and sclera.	6 nodules.	3 months	None	September.
38	Parker, W. R.	1910	No.	*Bombyx rubi*	Yes.	Cornea.	5 nodules.	6 months.	3 recurrences at monthly intervals.	October.

* Kruger's case reported 12 years later. It is not included in the summary as a separate case.

Examination.—The eyelid was slightly swollen and the conjunctiva conjested. With oblique illumination there could be plainly seen 5 areas of infiltration, situated in the superficial layers of the cornea. One was 1 by 3 mm. in size, running horizontally at the level of the upper pupillary margin. The other four, from 1 to 2 mm. in diameter, were siuated in the upper third of the cornea about midway between the pupillary margin and the limbus. The epithelial layer was intact, the infiltrated area apparently involving the basement membrane. The cornea between the areas of infiltration was clear except immediately adjoining the opacities where it was slightly clouded.

Treatment.—When I first saw the patient he was not suffering severely, and the possibility of caterpillar hairs being the etiologic factor did not occur to me. A careful examination did not reveal the presence of the hair, but after seeing the man in one of his acute attacks when the pain was severe, photophobia intense and the pericorneal injection marked, and the cornea had become striped about the large area of infiltration, I determined to curette the indurated areas. From the scrapings I recovered the small hair shown in Figure 1, eight months after the first attack.

Species of Caterpillar.—In September, I asked the patient to bring me a caterpillar like those he burned out of the trees the year before. This he did, and the hair shown in Figure 2 was taken from the specimen which was classified as the *Bombyx rubi.*

Result of Treatment.—In a comparatively short time the patient was well, although some thin scars were left in the cornea at the site where the hairs were removed. As none of the scars were central his vision was unimpaired.

In the accompanying table the cases of ophthalmia nodosa are arranged chronologically. The table contains, so far as I am able to determine, all the accepted cases reported to this date.

In a majority of cases there is a history of injury to the eye by a caterpillar; in the absence of this history there is one of sudden onset of the symptoms, consisting of pain, more or less severe; much photophobia and lacrimation. These symptoms tend to subside after a few days, but do not entirely disappear. In the course of a few weeks an exacerbation of all the symptoms occurs. The time between the date of infection and the first consultation varied from four hours to six months. The period of time that elapsed between recurrent attacks varied from four days to three years.

The different tissues of the eye affected were as follows:

1. Conjunctiva: 24 cases = 62.1 per cent. of 37 cases.
2. Cornea: 18 cases = 48.6 per cent. of 37 cases.
3. Iris: 16 cases = 43.2 per cent. of 37 cases.
4. Cornea, only: 4 cases = 10.8 per cent. of 37 cases.
5. Sclera: 3 cases = 8.1 per cent. of 37 cases.
6. Episclera: 2 cases = 5.4 per cent. of 37 cases.
7. Chorioid: 1 case = 2.7 per cent. of 37 cases.

In every case reported, there was either a definite history of injury with a caterpillar or the presence of a caterpillar hair was demonstrated. There was a history of injury in 27, or 73 per cent., of the cases, while the hair was demonstrated in 32, or 86.4 per cent., of the cases. The species of the offending caterpillar was determined in 16, or 50 per cent., of the cases in which the hair was found.

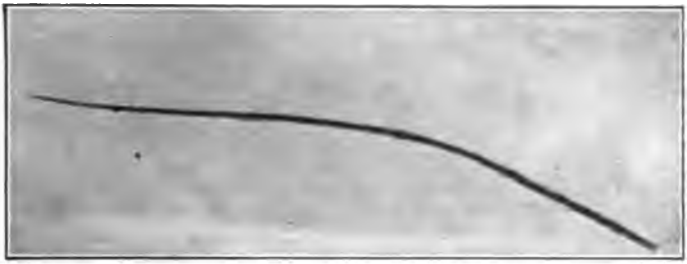

Fig. 1.—Photomicrograph of hair removed from author's case. x 62.

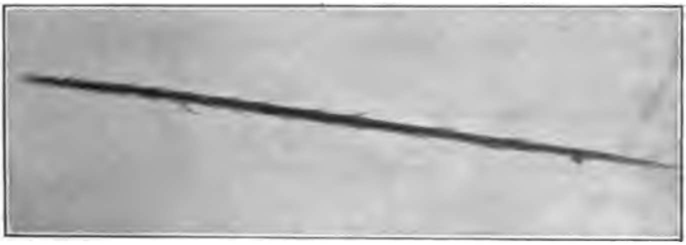

Fig. 2.—Normal hair of caterpillar. x 31.

The following species of the caterpillar were demonstrated: *Bombyx rubi,* 10 times; the *Knethocampa processionea,* 3 times; the *Bombyx pini,* 2 times; and the *Spinning bombycina* and the *Spilosoma virginica,* each, once.

The treatment adopted in the reported cases has been in the main symptomatic. The local remedies employed have been those usually prescribed in the treatment of iritis. The resemblance of the corneal lesions to those found in keratitis punctata superficialis of Fuchs has lead in some cases to the administration of mercury, but without results. Operative treatment has been limited to iridectomy, to combat iritis or increased tension, and for the excision of nodules and hairs.

The prognosis in ophthalmia nodosa should be guarded. It will depend on the tissues involved, the severity of the case, and the extent of the structural change present.

I wish to acknowledge the assistance rendered me by Dr. George M. Waldeck in the preparation of this paper.

Chamber of Commerce Building.

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MEMORANDA

SPONTANEOUS RUPTURE OF THE EYEBALL

A PHENOMENON OF GLAUCOMA *

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Author's Case.—Mr. S. C., aged 68, resident of Kentucky on a visit to Memphis, had been given a letter of introduction to me by Dr. J. M. Ray of Louisville. On the night of Dec. 9, 1904, about 9 o'clock, I was called to see him on account of a sudden pain in his left eye, accompanied by bleeding. He had undressed and retired, and afterward felt a desire to go to stool. His bowels moved without straining, and he again retired. After lying down he began to bleed from the left eye, and immediately to experience a severe pain. I found him still suffering such pain as to require half a grain of morphin to relieve him. The eye showed a large clot protruding from a rupture in the cornea, the corneal wound being about 10 mm. long. Oozing of blood was still going on, and the eye was so painful that pressure could not be applied. The bleeding continued for an hour and a half, finally ceasing from the effect of ice-pads lightly applied, or the morphin, or else spontaneously. A light dressing was then applied, and on December 12 the eye was enucleated.

The previous history of this patient is gathered from Dr. Ray's notes, of which he has kindly sent me extracts. Dr. Ray had seen the patient, aged then 65, first in 1901, for an iritis in the right eye. This subsided, with vision 20/30. The left eye, in December, 1901, showed floating opacities in the vitreous, opaque lens striæ and some plastic deposits on the anterior capsule, with synechia. The patient counted fingers at two feet. In 1904 Dr. Ray saw the patient again, with increased tension in the left eye, ciliary injection and hazy cornea. The condition was controlled by eserin, and operation was declined. A few weeks before I saw the patient Dr. Ray examined the eye again. The iris was almost completely adherent to the lens, and looked muddy; the cornea was normal, eye blind, and there was some ciliary injection and lachrimation, tension normal. There was extensive destruction of the framework of the nose, and an old specific history.

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* This paper has been accepted by the Executive Committee of the Section on Ophthalmology of the American Medical Association, to be presented at the St. Louis Session, June 7-10, 1910. Publication rights reserved by the American Medical Association.

To return to what I can relate from personal observation, there was marked arteriosclerosis, urine and heart normal. No cause for the rupture was discovered. There was no history of any sort of injury or straining or effort, if we accept the patient's statement that he had not strained at stool. The eye

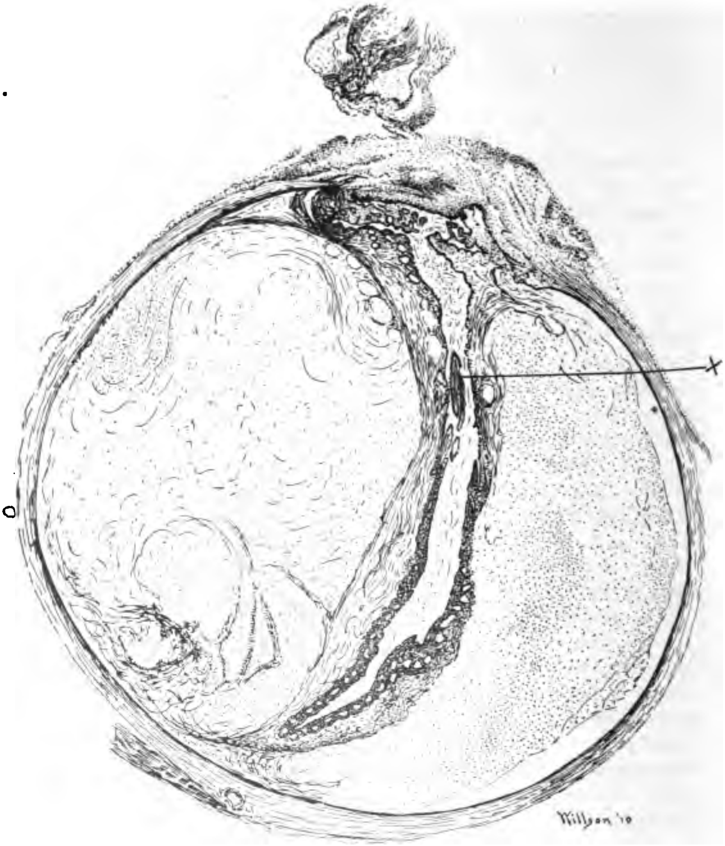

Figure 1.—A section of the globe under low power. The swollen corneal tissue, infiltrated with round cells, is seen, with a mass attached to it consisting of blood and ocular membranes. The tear in the cornea can be located by tracing Descemet's membrane. The cleft in the center of the ball is formed by folds of the chorioid. At X is a portion of the retina. Between the chorioid and sclera is a large hemorrhage, which has detached both chorioid and ciliary body, folding the latter forward against the iris. The lens is not seen. The section passes well to one side of the disk.

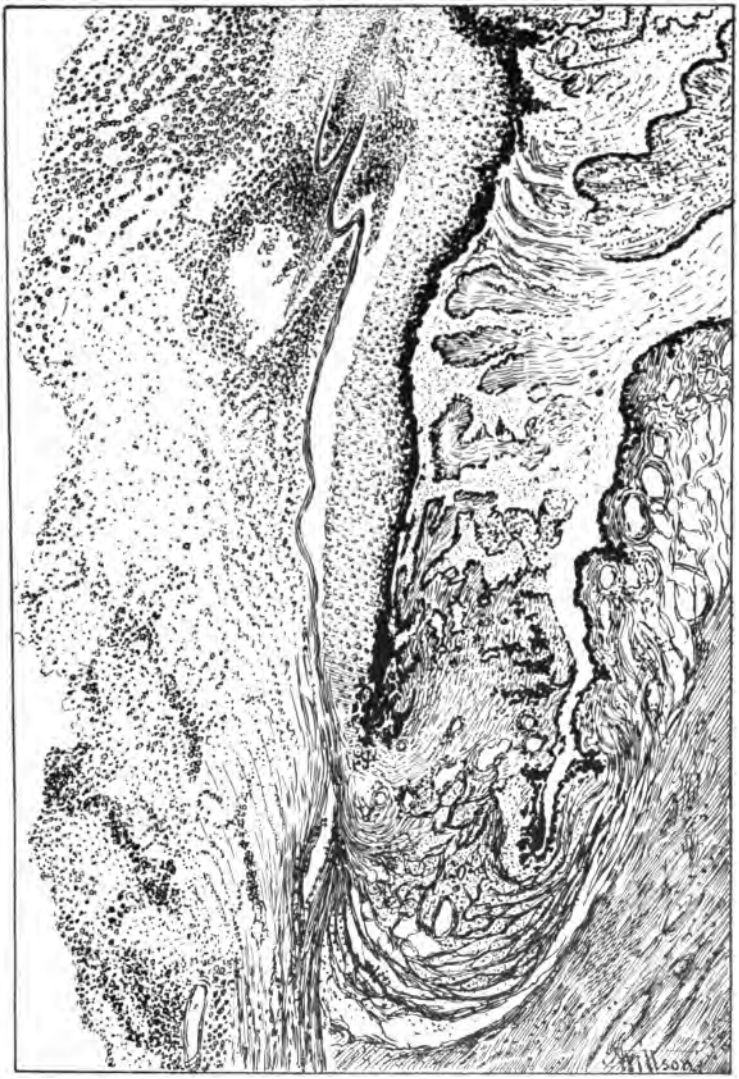

Figure 2.—The iris, ciliary body, cornea and angle of the anterior chamber are shown under higher power. The thickening and infiltration of the cornea, the tear in the cornea and the detachment and folding forward of the ciliary body are shown.

had been a little red and painful for two or three days, and it is reasonably sure that this was due to or accompanied by an increase of tension, judging from the history as related, and the microscopic appearance of the nerve-head, as subsequently determined. The eye was enucleated under ether and without any accident. The socket healed in the usual time.

The right eye was found to be the seat of an incipient cataract, vision 20/80, with — .75 S. with — .50 Cyl. Ax. 140° = 20/40, add + 3 S. = J. iii. The retinal veins were tortuous and indented by the arteries; arteriosclerosis was present. The nose and pharynx both showed evidences of former specific ulceration, in the shape of extensive scars.

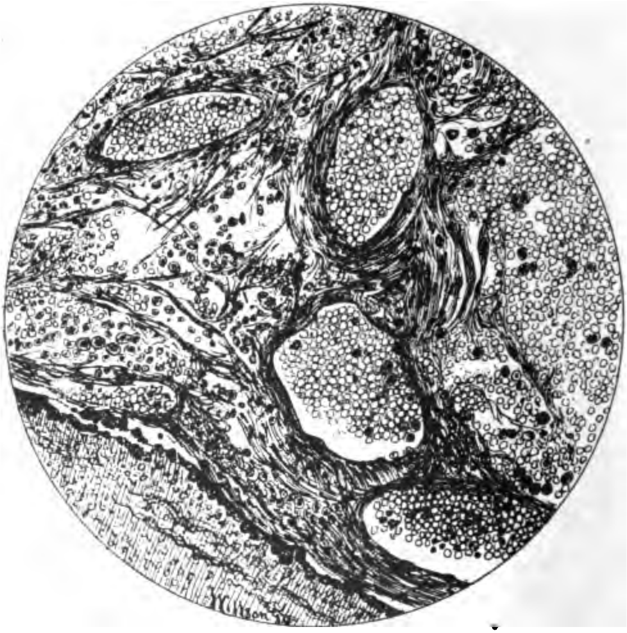

Figure 3.—A section to show the chorioidal vessels under higher power.

The patient died in the summer of 1909, and as far as could be ascertained the right eye remained good. The cause of death was not learned.

The eye was sent to Dr. Brown Pusey, to whom I am indebted for the report on the condition of the eye, as follows:

"Macroscopically a section in the antero-posterior diameter shows a hernia of the ocular contents through the center of the cornea. The retina and chorioid are detached except at the nerve-head, and these tissues make up the mass of the hernia. The space between the sclera and the detached chorioid and retina is occupied by blood (Fig. 1). The head of the nerve shows deep cupping.

"Microscopically the corneal tissue shows inflammatory changes of marked degree. The tissue is edematous and there is a great increase of cellular elements. There is no necrotic material such as one would find in an ordinary ulcer. The tissue of the limbus region shows the same changes; the new cells here are mononuclear cells. The arteries of the limbus region have markedly thickened walls, and in one set of sections marked inflammatory changes are seen in the outer wall of a large vein (periphlebitis). The prolapsed tissue is made up of vitreous, iris, chorioid, and retina, and all of them are edematous and full of blood. There is little to be made out of a study of the iris, chorioid, and retina, except the fact that the iris and chorioid are the seat of a great increase of cellular elements, and the vessels show marked thickening of the walls. (Figs. 2 and 3).

"The most striking changes found in the tissues are the changes in the cornea and the changes in the blood vessel walls. These changes probably explain the bursting of the eyeball and the hernia of its contents."[1]

The peculiar features of this case (I had never encountered a similar one, and Dr. Ray, a practitioner of much larger experience, apparently also had never seen a similar one) led to some search into the literature of the subject. In all, twenty-two cases have been collected, one reported in 1879 (Cheatham), one in 1881 (Vergely), and the others since 1899. The references quoted by Coppez of cases reported by Baster, Kyll, and Flemming, could not be found. The cases of McKenzie, if they are the ones referred to on page 449 of his book,[2] also quoted by Coppez, are cases of perforating corneal ulcer and not at all similar to the condition under consideration.

The following are the abstract reports of the twenty-two cases referred to:

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[1] Dr. Pusey adds that in his opinion the cornea ruptured first, and the blood vessels later from the sudden lowering of intra-ocular pressure. The probable sequence of events will be discussed later, but it would be well to say now that in forming an opinion from examination of the sections one must take into consideration the fact that the eye was not removed for several days after rupture, so that the inflammatory changes in the cornea had time to occur after rupture and before the eye was removed. It cannot be argued from the sections that the cornea was pathologic at the time of rupture.

[2] McKenzie: A Practical Treatise on Diseases of the Eye, Philadelphia, 1865.

Vergely's Case.[3]—A woman, 78 years old, with failing vision for three years, and opacity of the right cornea, arose one night and made an effort to urinate, after three days of pain in the right eye. A severe pain was felt in the right eye, followed by a free flow of blood from it. This was found to proceed through a tear in the center of the cornea. The bleeding ceased spontaneously, and the ball atrophied. Vergely thinks that the eye was glaucomatous, and that an intraocular hemorrhage occurred, which raised the tension sufficiently to rupture the cornea. The left eye showed a cataract.

Coppez's Case.[4]—A man, aged 69, had double chronic glaucoma. The right eye had been iridectomized, and showed cupping and atrophy of the disk, with impaired vision and contracted field. The left eye, not operated on, was almost totally blind. The left eye subsequently ruptured during a violent fit of anger, the rupture being characterized by severe pain and free bleeding. The eye atrophied and was removed nine months later. The lens was absent, the choroid and retina detached, but not expelled.

Professor Coppez's Case (quoted by H. Coppez).—A man, aged 65, had absolute glaucoma in the quiescent stage. Leaning to look under his bed, he was seized with a severe pain in the eye, followed by a free hemorrhage. A central rupture of the cornea was found, from which the ocular contents protruded. The eye atrophied. As this eye had not been seen immediately before the accident, it is not certain that the cornea was not ulcerated.

Wibo's Case.[5]—A woman, aged 65, with the left eye normal, had absolute glaucoma, with exacerbations in the right eye, controlled by pilocarpin. A whitish infiltration extended from the center of the cornea toward the periphery. During a slight effort the eyeball ruptured, and with a profuse hemorrhage the ball emptied itself of its contents and membranes. A horizontal tear occupied two-thirds of the corneal diameter, with ulcerated borders. Evisceration was performed.

Villard's Cases.[6]—*Case 1.*—The patient, aged 65, had simple chronic glaucoma in the right eye. One month after the first examination an attack of acute glaucoma occurred, for which an iridectomy was performed. A year later the eye, which had been comfortable, but had become blind, again became painful and an ulceration of the cornea was observed. This ulcer became infected and the ball ruptured suddenly with hemorrhage and such severe pain as to cause the patient to lose consciousness. The ball atrophied, and about eighteen months later the patient died from softening of the brain.

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[3] Vergely, P.: Bull. Soc. d'anat. et physiol. de Bordeaux, 1881, ii, 214.

[4] Coppez, H.: Sur les ruptures spontanées du globe oculaire dans le glaucome, Arch. d'Opht., October, 1908, xxviii, 609.

[5] Wibo, M.: Presse méd. Belg., Bruxelles, 1909, lxi, 193.

[6] Villard, H.: Arch. d'Opht., December, 1908, p. 768.

CASE 2.—The patient, aged 74, had absolute glaucoma of the left eye, with pain and hyphemia. Fourteen months later the conditions were about the same, with the addition of superficial ulceration of the cornea. The lower portion of the cornea was slightly bulged. Rupture of the cornea occurred, with subsequent atrophy.

CASE 3.—The patient was a man aged 65, with traumatic corneal ulcer, hypopion, chronic dacryocystitis and increased tension. During an effort at defecation the ball ruptured at the site of the ulcer, severe hemorrhage occurred and expulsion of the ocular contents. The ball atrophied.

VERHOEFF AND SPALDING'S CASE.[7]—A man, aged 64, had glaucoma, diagnosed as secondary. After two attacks of acute glaucoma, treated medically, he was free from pain for two years. He then had a third attack of glaucoma, at which time the cornea showed a complete yellowish infiltration. Enucleation was refused, and after five weeks the eye ruptured while the patient was quietly talking to his wife. The ball was enucleated. The ocular contents and membranes were found to be extruded. The edges of the corneal wound were infiltrated with polynuclear leucocytes. The globe contained a small round-celled sarcoma.

MILLIKIN'S CASE.[8]—The patient was a woman, aged 68, blind from absolute glaucoma in both eyes. While she was quiet in her room one eye ruptured, producing a vertical tear of the cornea, extending into the sclera above. Profuse hemorrhage and subsequent atrophy occurred. There was no history of any corneal disease.

ZIMMERMAN'S CASE.[9]—A healthy woman, aged 56, had a corneal ulcer involving one-half the corneal thickness and almost its entire area, in an eye previously damaged by glaucoma. Without apparent cause the ball ruptured, the tear being horizontal and about 7 mm. long. A large hemorrhage, carrying with it the crystalline lens, occurred. The ball was enucleated.

TERSON'S CASE.[10]—A woman, aged 71, with chronic glaucoma in the left eye for eight years, had been blind one year. She had many attacks of pain. A vertical rupture of the cornea was found, with protrusion of the contents of globe. The patient had experienced a violent pain in the eye after going to bed, but this subsided and she went to sleep. An hour later she awoke to find that a hemorrhage had taken place. The protrusion was cut off and the ball healed.

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[7] Verhoeff and Spalding: Arch. Ophthalmology, 1901, xxx, 389.

[8] Millikin, B. L.: Tr. Am. Ophth. Soc., 1899, p. 488.

[9] Zimmerman, M. W.: Ophth. Rev., 1899, xviii, 141; Ophth. Rec., April, 1902.

[10] Terson, M.: Ophth. Rev., 1901, xx, 47.

GAMO PINTO'S CASE.[11]—A woman, aged 63, had absolute glaucoma in the left eye. The right was also glaucomatous, and was operated on (iridectomy) with good results. The cornea of the left eye ulcerated later. After two weeks the cornea ruptured, followed by a profuse hemorrhage and expulsion of the ocular contents and membranes. The eye was enucleated.

CHEATHAM'S CASE.[12]—A woman, aged 65, born blind in the left eye, for four years had been subject to attacks of severe pain, lasting several weeks. During such an attack the ball ruptured, the lens escaped and a profuse hemorrhage followed. The ball was enucleated, and the retina and chorioid found to be detached and the ball filled with clotted blood.

BIALETTI'S CASES.[13]—*Case 1.*—The patient was a man, aged 70. The right eye was lost from trauma. For ten months he had had attacks of acute glaucoma in the left eye. In both eyes tension was + 3, the diagnosis being absolute glaucoma with cataract in the right eye, and recurrent glaucoma in the left. The lens was extracted from the right eye with loss of a "quantity of vitreous and blood." In the left eye sclerotomy, and later, iridectomy, was performed. The right eye atrophied, and three years after the operation the left eye ruptured, with violent pain, hemorrhage and loss of the lens and vitreous. The cornea was ruptured parallel with its circumference. The protruding mass was excised and the eye became quiet.

CASE 2.—A man, aged 75, had glaucoma in the right eye for thirteen years, during which time he had undergone iridectomy. Rupture of the ball occurred with hemorrhage and extrusion of the ocular contents. Excision of the protruding mass was followed by atrophy of the ball.

LISSIGYN'S CASE.[14]—A woman of 65, blind for a year, had severe hemorrhage with a rupture 4 or 5 mm. long in the lower third of the cornea; described as a perforating ulcer due to glaucomatous degeneration.

GILFILLAN'S CASE.[15]—A woman, aged 87, with paralysis agitans and poor mental and physical condition and arteriosclerosis, had senile cataract and large corneal opacities in each eye, but no staphyloma; no note as to tension. While

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11. Pinto, Gamo: Encyclopédie française d'ophtalmologie, 1906, v, 52.
12. Cheatham, W.: Louisville Med. News, 1879, viii, 292.
13. Bialetti, C.: Ann. di ottalmol., 1908, xxxvii, 27.
14. Lissigyn: Aug. Gesellsch., 1900; Cf. Coppez, H.: Bull. et mém. Soc. franç. d'Opht., 1908, xxv, 287.
15. Gilfillan, W. W.: Tr. Ophth. Soc., New York, Acad. Med., Arch. Ophth., 1902, xxxi, 66.

lying in bed she experienced a sharp pain in the left eye, and when the house surgeon reached her there had been a large hemorrhage from the eye, with expulsion of the lens and prolapse of the iris. The protruding mass was cut away and the eye healed. The rupture was in the center of the cornea and large enough to permit the lens to escape.

Fage's Case.[16]—A man had absolute glaucoma, with exacerbations, in the left eye. At one visit for such an attack the cornea was noted to be sound. Two and a half months later he returned with a horizontal central rupture of the cornea, 3 mm. long. There was no escape of the ocular contents, though the anterior chamber was filled with blood and clots lay in the corneal wound. Enucleation was performed.

Shepherd's Case.[17]—A woman, aged 81, had chronic glaucoma in one eye for a few years. The eye was blind and for a week had been painful. One night the ball burst across the middle of the cornea, this being followed by free hemorrhage and partial escape of the ocular contents. The eye was removed. The cornea did not show any evidences of ulceration.

Ingall's Case.[18]—A woman, aged 89, had been blind in the right eye for two years. Following a severe pain the eye ruptured, with free hemorrhage and protrusion of the iris through a rent in the lower half of the cornea. The eye was removed and the whole contents found to have been expelled. The margins of the corneal perforation were smooth and not ulcerated.

Hauenschild's Case.[19]—A woman, aged 28, with apparently normal eyes, was seized with a violent pain in her right eye. The next day there was widespread subconjunctival and subpalpebral ecchymosis, and slight exophthalmus. The anterior chamber was entirely filled with blood. The eye was blind. When the blood was absorbed a rupture was seen in the sclera, 1 mm. above the corneal border, into which the iris had prolapsed. The rupture was 6 mm. long and concentric with the corneal border. The blood was absorbed and the eye shrunk. The other eye was normal.

Houdart's Case.[20]—A man, aged 72, was blind in both eyes from glaucoma. The right eye was affected also with a cataract and had been blind four years. While working in a stooping position cutting grass, the patient was suddenly siezed with a frightful pain in the head, vision seemed red, and he fell unconscious to the ground. Three hours later the cornea was found to be ruptured through the middle, an abundant hemorrhage had occurred and the lens and probably other ocular contents had escaped. No intervention was allowed.

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[16] Fage: l'Opht. prov., February, 1909; abstr. in Ophthalmoscope, January, 1910, viii, 42.

[17] Shepherd, Cyril: Ophthalmoscope, 1909, vii, No. 7.

[18] Ingalls, J. W.: Tr. Am. Ophth. Soc., 1909.

[19] Hauenschild: München. med. Wchnschr., 1900, No. 31; abstr. in Ann. Ophth., 1900, ix, 657.

[20] Houdart: Clinique Opht., July 26, 1906; abstr. in Ophthalmology, January, 1907, and Ann. of Ophth., xv, 603.

Ball's Case.[21]—Ball merely mentions that he has seen such a case.

It will be noticed that the patients, with one exception (Hauenschild), were old people, aged from 56 to 89. Indeed, with the single exception of Zimmermann's patient, aged 56, none were less than 63. In two instances (Fage and Ball) the age is not mentioned. Hauenschild's case is evidently in a different category from all the others, and, excluding this case, the patients were all the subjects of chronic glaucoma. In many of them this was established before the rupture of the eye; in others the subsequent examination or previous history makes the presumption of glaucoma plainly justifiable. The hemorrhage in all cases proceeded from the vessels of the chorioid, and the rupture of the ball occurred in the cornea. In nearly all of the cases these phenomena were spontaneous, there being usually no apparent cause, such as trauma or straining. We might profitably consider this condition, since the number of cases reported indicate that it is not so rare but to be of general interest, and inquire how it happens, when and why it may happen, and what is our duty in case it does happen.

In inquiring how spontaneous rupture of a glaucomatous eye comes about, we find a difference of opinion among those who have observed it. Some assert that the rupture of the cornea is primary, and due to the perforation of an ulcer, or the traumatic rupture of an ulcerated or otherwise weakened cornea, the resulting lowered tension permitting the unsupported intra-ocular vessels to break, with resulting hemorrhage. Others contend that the intra-ocular hemorrhage is primary, and that the increased tension causes rupture of the cornea, which may or may not have been previously weakened by disease.

Whichever view we consider, it can be justified by analogy, which is well, since in a given case one cannot always be sure of the sequence of events. In favor of the idea that the rupture of the cornea is primary and the hemorrhage secondary, the occurrence of chorioidal hemorrhage during a cataract extraction could be cited. Here we see the rupture of the chorioidal vessels occur when the corneal incision and evacuation of aqueous has lowered the pressure which supports the vessels. In support of the other theory, that the hemorrhage is the primary event, the occurrence of cerebral hemorrhage might be regarded as analogous. With or without apparent exciting cause, but presumably accompanying an increase of blood-pressure from some cause, the diseased vessel breaks. The question now arises whether a hemorrhage from the choroidal vessels can increase the intra-ocular pressure to such a point that rupture of the cornea will follow. Among those who have reported cases a difference of opinion is found. Villard, Verhoeff and Spalding, Valude (discussing Terson's cases, q. v.), Gamo Pinto, Bialetti and Lissigyn, express themselves more or less emphatically to the effect that the sequence of events is, first, the rupture of an ulcerated cornea, and then the hemorrhage. Verhoeff and Spalding, in particular, question the possibility of a hemorrhage raising the pressure enough to rupture the cornea, since the intra-ocular pressure is already as great as, and dependent on, the blood-pressure. A rupture of an intra-ocular vessel, then, does not, according to these observers, increase the intra-ocular tension. On the contrary, Wibo, Gilfillan, Millikin, Fage and Ingalls think that the hemorrhage preceded, and presumably caused, the rupture in the cases they observed. Shepherd says that the cornea in his patient was normal, and to the best of my belief it was in my patient as well.[22]

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[21] Ball, J. M.: Modern Ophthalmology, Philadelphia, F. A. Davis and Co., p. 418.

In cases not observed before rupture it may be hard to tell, since all of the ulcerated corneal tissue may be torn away by the passage of the blood and membranes through the rent. While the pathologic report on the case herewith presented speaks of infiltration of the cornea, the fact that enucleation was not done till three days after the rupture gives a sufficient interval to permit these changes to have taken place after the accident. In this connection I would call attention to the drawings of the microscopic sections.

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[22] It is interesting to note that at the end of the abstract of Houdart's case appearing in the Annals of Ophthalmology (xv, 603), the reviewer doubts the possibility of any intra-ocular hemorrhage having sufficient force to cause a rupture of the cornea, and thinks that the hemorrhage was probably spontaneous, but the corneal rupture almost certainly caused by the patient striking the eye when he fell unconscious to the ground.

In reference to the point raised by Verhoeff and Spalding, we now believe that the intra-ocular fluids are not secretions, but the product of a filtration process. Such a filtration can take place only when the pressure in the blood-vessels, whence the fluids come, is greater than the pressure within the eyeball, into which the fluid filters. The intra-ocular pressure cannot exceed the blood-pressure, but, on the other hand, it would seem that the blood-pressure must exceed the intra-ocular pressure. It has been shown experimentally[23] that when the intra-ocular pressure is raised to 50 mm. of mercury filtration ceases. This would indicate the intravascular pressure, which is about twice that of the normal intra-ocular pressure. If this is correct, then blood escaping into the eye with a *vis a tergo* equal to the intravascular pressure could exert sufficient force to rupture a weakened cornea.

The occurrence of this distressing accident is predicated on the existence of several conditions. A study of the reported cases would justify one in saying that these conditions are glaucoma, vascular disease and probably an ulcerated or otherwise weakened cornea.

Glaucoma, on theoretical grounds, would not appear essential to the occurrence of this accident, but, in fact, it is present with too great regularity to be regarded as a coincidence. The vascular changes, with increased blood-pressure, necessary to produce the condition in question, seem always to produce glaucoma, a fact easily understood in the light of the now general appreciation of the close relation between glaucoma and vascular disease.

The vascular changes have been more often inferred than demonstrated in the reported cases. While arteriosclerosis is often mentioned as being present, the conditions of the blood-vessels in the enucleated eye are mentioned only by Coppez and Ingalls. Degenerative and proliferative changes in the blood-vessels of the retina and uveal tract are described by these writers, those in the uveal tract being the ones that concern us most. The changes described and illustrated in my own case may be regarded as typical.

It is well known that hemorrhage into a glaucomatous eye may occur without producing rupture of the cornea.

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[23] Niesnamoff: Arch. f. Ophth, 1906, xlii, 4; Quoted by Parsons: The Pathology of the Eye, New York, 1906, iii, 967, G. P. Putnam's Sons.

Such a case is described by Graefenberg,[24] and they are probably not very rare. They are sometimes erroneously referred to as cases of hemorrhagic glaucoma.

In the absence of the necessary degree of vascular degeneration and increased blood-pressure, the cornea can be ruptured or destroyed in a glaucomatous eye, without precipitating a hemorrhage. The commonest example of this is when an operation, involving corneal section, is performed for the relief of glaucoma. In addition to these common instances, two cases have come under my notice which still further emphasize this point.

A woman, aged 60, without manifest vascular disease, was attacked with glaucoma in the right eye in September, 1907. Although repeatedly advised by her physician to be operated on she would not consent. I was asked to see her on July 13, 1909, and found the whole cornea destroyed, its place being occupied by the iris, covered with granulations. Enucleation was performed without accident.

A little boy, aged 5, was brought to me for an injury to his right eye from a fall. I found buphthalmia and extensive corneal rupture. There was no intraocular hemorrhage, doubtless owing to the normal condition of his blood vessels. The eye was enucleated.

This is an occurrence, then, that must be put in our category of possibilities in cases of chronic glaucoma of the subacute or chronic congestive type. Simple glaucoma apparently does not cause it, and acute glaucoma would probably cause a scleral ectasia (ciliary staphyloma) instead.

The indications for treatment are briefly stated. The eye is lost and in general should be removed. If not it will atrophy. There is no exception to this in the reported cases in which the eye was not removed. No sympathetic trouble seems to have been so far observed to follow the retention of an eye so damaged, one cause of its non-occurrence being the advanced age, and consequent short subsequent lives, of the unfortunate patients.

Randolph Building.

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[24] Graefenberg: Arch. f. Augenh., September, 1906, lvi, 1; abstr. in Ann. Ophth., 1907, xvi, 355.

MEMORANDA

AUTO-INTOXICATION AND ALLIED INTESTINAL TROUBLES

AS A POSSIBLE CAUSE OF CERTAIN VASCULAR AND FUNCTIONAL DISTURBANCES OF THE EYE *

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This paper is the result of a personal conversation in October last, the participants being our Chairman and Secretary and myself. We met in Philadelphia, at the invitation of the Chairman, to discuss the program for this meeting.

Among other matters, ocular disturbances from various toxic influences was considered. The papers which have already appeared were reviewed, and especially the pioneer work of de Schweinitz with his chemical helpers, Edsall and Fife. These researches, it will be recalled, had to do with inflammatory lesions, specially those of the uveal tract. We thought of lid, conjunctival and various functional anomalies of the ciliary structure, things of daily observation, which resist local treatment, are prone to relapse, and which are not uncommonly associated with those remote symptoms which de Schweinitz has aptly defined as "conjectural." That is, one finds associated with certain lesions of the lid structures or functional derangement of the anterior uvea—just the history and symptoms which, if associated with uveitis, would lead one to think that the internist (having at command chemical means to investigate defects of metabolism) could throw light on etiology. Is there more in this than association? If so, how far has the physiologic chemist enabled us to go?

This question was put to Dr. Edsall, and he was invited to follow an interrogatory paper with one

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explaining what we want to know. His reply was that he felt that, after his contributions, accessible to all, there was nothing more definite to add. We felt that it was useless to seek farther. Still, our own clinical observations led us to think the matter worth presentation, and this position has been, since October, confirmed by a paper by Dr. J. F. Shoemaker[1] of St. Louis. The lesions of the adnexa which I wish to consider are those of the lids and mucosa. De Schweinitz describes the former in his text-book under the title, "Hyperemia of the Lid-Border (Hyperemia Marginalis, Vasomotor Blepharitis)." He says:

> The margins of the lids have an unpleasant, slightly swollen, red appearance. Exposure to cold, wind or any strain on the accommodation causes a feeling of heat followed by burning and lacrimation. The redness is caused by the passive congestion of the superficial blood-vessels. Scales or crusts are absent, or but sparingly present.

Discussing the etiology of blepharitis, without specially mentioning the vasomotor variety, but evidently with it in mind, he says that it may follow in the wake of an exanthem, may result from ametropia, "inflammations of the tear-sac, stricture of the nasal duct, and obstructive disease of the posterior nares, although it may be difficult—to decide whether the blepharitis has caused the closure of the lacrimal passages or whether this has developed the blepharitis." Dr. Shoemaker, presenting the clinical conjunctival picture, with a possible autotoxic cause in view, says:

> As a rule, the cases I have observed have very little or no secretion. The eyes feel uncomfortable, particularly with their use in artificial light, and the blood-vessels of the bulbar conjunctiva are considerably engorged. The diagnosis must be made, however, from the history of indigestion or constipation, together with other symptoms of autointoxication. Some of these symptoms are drowsiness, especially after eating, dizziness, periodic attacks of headache, certain diseases of the skin, particularly of the erythematous or urticarial types, various nervous disturbances and aching and stiffness of the muscles which might be confused with, or attributed to muscular rheumatism. The patients may not complain of any of these symptoms, but inquiry will usually develop the fact that they suffer with one or more of them.

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[1] Shoemaker, J. F.: Etiology and Treatment of Certain Forms of Conjunctivitis, Am. Jour. Ophth., January, 1910.

Before attempting to couple the lid and conjunctival disturbances and discussing the possibility, in certain cases, of an autotoxic cause, I want to add a third class. I allude to recurrent circumcorneal injection, recurrent asthenia of the ciliary muscle, spasm of accommodation, and the condition known as hysterical accommodation spasm, or cyclospasm. It is well described in Posey and Spiller's book, "The Eye and Nervous System." It has been studied specially by Parinaud, and his description is given:

> The spasm may be partial or total, unilateral or bilateral. It is similar to that produced by eserin, and has as its chief characteristic a displacement toward each other of the punctum proximum and the punctum remotum—that is to say, there is a diminution of accommodation at both ends of the line.

Here, then, are three vascular or functional troubles which we see constantly in routine practice. To connect them with remote causation demands first, painstaking exclusion of known causes. For instance, in hyperemia of the lids, lacrimal obstruction, as de Schweinitz observes, is frequent. As he says, again, it is not always easy to say which stands as cause, infection to the lids from the excretory apparatus, or to the latter from the lids. I am sure that often the course is toward the lids, and that at least one factor can be readily overlooked. Definite accumulation of mucus in the sac or persistent epiphora are easy enough; but lesser grades of obstruction are not so readily diagnosed. Ziegler told us about this years ago, and devised probes of great value. I am sure that infection, or, possibly, irritation, from the nose can often do no more than cause catarrhal swelling of the mucosa in the canaliculus or even shutting of the puncta. Chronic hyperemia of the lids often disappears after dilatation of the puncta and canaliculus without going into the duct at all. Nitrate of silver solutions of 2 to 5 per cent., applied to a swollen turbinal, and a somewhat persistent use of such a mildly stimulating agent as an oil solution of menthol in the nostrils, often cure chronically congested lids. Injection of the conjunctiva, as described by Shoemaker, stands in close relation to lid hyperemia. The structures are but parts of one vascular area.

Circumcorneal injection, in the absence of corneal lesions, of course, focuses attention on the anterior part of the uveal tract. This brings us to the most important of the recognized causes of lid and conjunctival hyperemia and functional disturbances of the ciliary muscle, namely, refraction and muscular errors, and the varied relations they have to each other. It is not my purpose to do more than mention this causative factor. In such an association, for instance, as hyperopia and exophoria, one could naturally look for relapsing ciliary cramp; but every clinician knows that cases occur in which his best efforts, along line of recognized causes, fail to cure. If at first relieved, the patients relapse. Why do they not stay cured?

A second essential, if relapsing eye troubles are to be attributed to remote disturbances, is the more or less constant association of ocular lesions or derangement of eye function, with symptoms of the supposed causative disease. This association, I take it, is what de Schweinitz means by the presence of certain things which leads one to "conjecture" a toxic cause. If one of the three classes of eye trouble occurs when the patient is constipated, when he has periods of neuralgia, when he is suffering from what he calls "nervous dyspepsia"; if local remedies do not relieve, or, at the most, give only temporary relief; if all these symptoms, including those of the eye, clear up when the remote trouble is removed, then we are justified in suspecting causative relation. If these simultaneous eye and remote troubles occur not once, but repeatedly, and if they occur not in one, but in many patients, this suspicion becomes a conviction. I do not consider it necessary to prolong my paper with narration of cases; brief allusion to one will suffice.

A man of 25, total refraction error D 1. of hyperopia, with less than D 0.5 astigmatism with the rule. Vision immediately after cycloplegia distant vision (d. v.) 20/15; near-point accommodation 12 cm.; orthophoria, d. v., exophoria 3° at near.

Gradually, from this state of things, he develops a reduction of d. v. to about one-half, with recession of his near point to 30 cm. With or without correction of his low error, this thing occurs. Why? Invariably, in three or four such experiences, he has given a history of pain after eating and constipation; there has been foul breath, and he has learned that this association exists. He leads a sedentary life, and makes his living by keeping books. Homatropin restores normal eye function, and so long as he keeps his diet regulated, and constipation does not overtake him, ciliary cramp does not return.

This case is narrated because I have linked ciliary disturbances with those of the lid and its mucosa. Dr. Shoemaker has covered these sufficiently.

While we can eliminate recognized causes, and prove clinical association, we cannot as yet fulfill a third condition—explanation of pathogenesis. We call it autointoxication; and there are good reasons for so doing. For instance, we see conjunctival hyperemia and "vasomotor" blepharitis in diseases of known infectious origin; note their occurrence in the beginning, through the course and after the exanthemata. We see all grades of ciliary involvement, from asthenia of transient type to complete and stubborn paralysis, after various infectious diseases, typhoid fever, chicken-pox, scarlatina and diphtheria. These lesions we attribute to toxins, and it is to be specially noted that since the advent of diphtheria antitoxin we see fewer cases of postdiphtheritic paralysis.

Secondly, in diseases not themselves infectious, but capable of forming toxins, we note similar eye troubles. Nephritis, diabetes and occasionally pregnancy serve as examples.

Thirdly, there is good reason for thinking of the intestines as the source of this autotoxic influence. After the proved association between uveitis and intestinal disorders, the work of de Schweinitz and Fife seemed to afford chemical proof of a pretty satisfactory nature. Cases of pupillary derangement, clearing up after expulsion of intestinal parasites, are recorded. Bruns of New Orleans recited such a case in discussing my paper[2] on ocular neurasthenia at our meeting in 1907. There is the peculiar edema of the conjunctiva in trichinosis. In two cases I saw during the past winter, the edema involved the bulbar conjunctiva, between the limbus and external canthus, presented a peculiar yellowish reflex, and was totally inexplicable, till fever, blood examinations, etc., cleared the diagnosis. In the first volume of Osler's "Modern Medicine" this eye symptom of trichinosis is recorded.

The reason, then, for calling these eye disturbances, associated with various intestinal disorders, "autotoxic" is that they bear a strong similarity to eye troubles of either known general infectious nature, or to those seen in systemic diseases capable of producing toxins. Shoemaker attributes the conjunctival congestion to the fact that the conjunctival "substantia propria consists of adenoid connective tissue which is richly supplied with blood-vessels and lymphatics, the walls of which are irritated, and become diseased by these poisons." He quotes Deland as authority. Such effects on blood-vessels, with subsequent exudates and hemorrhages, are well-recognized results of toxemia. So, too, are varying degrees of interference with muscular function, from slight impairment to complete paralysis. In the presence of changes, characteristic of toxemia, it is but natural to think of the latter as a cause, in spite of the fact that we do not know the toxin at work or are even sure that there is any such influence. Autotoxic diagnosis is a matter of inference, though undoubtedly the most probable, in our present state of knowledge. This is as far as we can go till the physiologist and chemist blaze the way. So far they have not given us very dependable diagnostic means or explained pathogenesis much beyond the hypothetical stage, at least so far as my limited knowledge goes. A recent publication shows their own uncertainty. Among the Oxford medical publications of last year is a most interesting and instructive book by Arthur F. Hertz, entitled "Constipation and Allied Intestinal Disorders." Speaking of auto-intoxication or copremia, Hertz says:

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[2] Woods' H.: THE JOURNAL A. M. A., July 20, 1907, xlix, 211.

> There is no entirely satisfactory method of estimating the activity of bacterial decomposition in the intestines. Jaffé thought it could be measured by the amount of indican, and Baumann by the amount of ethereal sulphates in the urine. The results obtained, however, give no definite indication as to the degree of autointoxication, which may be present, as different putrefactive bacteria produce different products, some of which are comparatively innocuous, whilst others are excessively poisonous. Hence an increase of the quantity of indican or ethereal sulphates in the urine is no evidence that excessive production of other more poisonous products is occurring, and on the other hand, it would be quite possible for severe intestinal auto-intoxication to occur in the complete absence of any change in the urine which could be demonstrated by Jaffé's or Baumann's methods. Both indican and ethereal sulphates have been found to be increased in some cases of constipation, but by no means constantly . . . and Strauss and Philippson found a diminution in the ethereal sulphates as often as an increase. When excess of these substances is present in the urine of constipated individuals, it may just as well be due to the increase in the quantity absorbed, owing to the longer stay of the feces in the colon, as to an in-

> crease in the quantiy produced. . . . There is thus at present no chemical evidence that an abnormal amount of decomposition occurs in the intestines of constipated people. . . . It is, however, possible that even in the absence of any increase in the production of poisons, the slow passage of feces through the intestines might lead to autointoxication by giving more time for the absorption of products of bacterial decomposition. But definite evidence is still wanting to show that the products of ordinary bacterial decomposition in the intestines can give rise to poisonous symptoms on absorption.

Hertz then discusses the poisonous effects of ethereal sulphates, sulphuretted hydrogen, "which is normally present in traces in the colon," ammonia, the amido-acids, indol, and concludes that all are only slightly toxic. Regarding the latter, he thinks that the amount apt to be absorbed in constipation would not affect a healthy individual, but that those "with an abnormal nervous system" would react. He sets aside ptomains as the cause of toxic symptoms in constipation because none has been found in the urine or feces of persons suffering in this way. He says:

> Volatile fatty acids and most of the products of bacterial decomposition of carbohydrates are rapidly oxidized in the body so that they are not likely to produce any poisonous effects. . . . It is, of course, possible that the symptoms are due to the absorption of some unknown poisons. But no accurate means have yet been devised for investigating this possibility. . . . Though there is no evidence that such a condition as copremia exists, yet many of the results of constipation are more easily explained by the theory of auto-intoxication than in any other way. This is particularly the case with some of the nervous symptoms. . . . This auto-intoxication is probably due to the abnormally long period during which the feces are present in the intestines, and to the consequent excessive absorption of poisons, and not to any increase in bacterial decomposition.

Relative susceptibility is then discussed. The liver is "the chief defense against auto-intoxication," and its power to convert toxic into harmless substances is presented. Even after absorption, no great harm is done if the eliminative organs are in good shape.

Lastly, Dr. Hertz states that the ultimate effect of toxic absorption depends on the state of the organ itself. He emphasizes the harmful effects of constipation in producing functional diseases and on "a depressed nervous system."

I have introduced these views of Dr. Hertz because they seem to me full of significance. Reduced to their simplest terms, they indicate that "auto-intoxication" from constipation and other intestinal disorders is but a working hypothesis, and seems to explain, better than any other, clinical findings. They also throw great doubt on the value of usual methods of chemical investigation. There are certain interesting clinical facts which I have observed, having some bearing on this contention. Exactly the same ocular symptoms which I have detailed have been observed in chronic appendicitis. Two of the patients suffered from repeated attacks of appendiceal pain before operation, and functional eye symptoms came immediately after their subsidence. One girl developed in different attacks "cyclospasm," a manifest astigmatism which disappeared after cycloplegia, and finally a chorioidal exudate. There were no symptoms of "auto-intoxication" and no constipation. The interesting point is that the patient had an inflamed adherent appendix removed four years ago, and has had no functional eye disturbance since. I alluded to this case in my paper on ocular neurasthenia in 1907. Of course, it is possible that the pain produced neurasthenia, and that the so-called "hysterical accommodation" resulted from this. Still, the girl is a remarkably level-headed person, and not in the least hysterical, in the ordinary acceptation of the word. The other patient was an educated woman in the thirties, who presented repeated and inexplicable lengthening of the punctum proximum. I knew nothing about her appendix symptoms till she came to tell me about a prospective operation. This was two years ago. I have seen her frequently, as she has come at my request, and I have never found relapse of the functional eye trouble. The only abdominal symptoms in both cases were those of appendicitis. I cannot connect auto-intoxication with these, and incline to the belief that there is some other path to eye irritation.

Again, in cases in which there has been association of eye anomalies with constipation and its toxic results, I have had the urine carefully studied. In some of them the chemical findings were negative; however, treatment directed to the intestines is keeping the patients well. Allusion has been made in this paper to unrecognized infection as a cause of the symptoms under consideration. I have now under care a woman, 63 years of age, who has had for twelve years peripheral lens striations of the non-progressive type. She preserves normal central vision. She is gouty, a free liver —or, rather, has been—and came to me this time for obstinate conjunctival congestion of the right lower lid. She brought with her a diagnosis of constipation, indicanuria, auto-intoxication, etc. There were no manifest symptoms of lacrimal trouble at first, and for several weeks we worked along autotoxic lines without improvement. Then she developed a not very annoying epiphoria, and a probe introduced into the duct showed no stricture. The canaliculus was not split. But from this time, under the one probing and repeated washing of the sac, there has been steady lessening of the chronic conjunctival hyperemia. By contrast the case shows the essential difficulties of diagnosis.

In conclusion, I think that there is enough association between the eye disturbances named and manifest symptoms of auto-intoxication from constipation to justify the belief of causative relation. There is reason to think that the same eye troubles can follow intestinal lesions which do not essentially produce toxic products. It seems that the physiologic chemist is not yet in position to help us much in proving the diagnosis, and that until he is we must study these obstinate cases from a clinical standpoint only. If we are ever to explain them or to relieve them, we must view the eye as the receiving as well as the sending end of what we call remote disturbances.

842 Park Avenue.

MEMORANDA

THE INCREASING FREQUENCY OF INHERITED SYPHILIS

THE GRAVE IMPORTANCE OF ITS EARLY RECOGNITION IN INFANTS AND YOUNG CHILDREN, FROM THE STANDPOINT OF THE OPHTHALMOLOGIST *

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For many years I have been deeply interested in the ocular lesions of inherited syphilis in young children, and for the last ten years I have directed special attention toward the early recognition of these lesions or stigmata in infants and very young children.

I think we will all agree that the gravest, by far the most serious consequences of syphilis, are those due to heredity. One of the greatest of social dangers is the high rate of infant mortality among the children of syphilitic parents; but a greater one is the disastrous results of heredity in those who live to maturity. Many of them pass through a stunted childhood into a still more stunted manhood or womanhood, to become a permanent charge on their family or on the state. The position assumed and maintained by the state and municipal authorities toward the so-called "social diseases" is eminently false, and has largely to do with the widespread ignorance on the part of the public of the far-reaching disastrous effects of such diseases. It should be the duty of the medical profession to demand from the authorities the right of the public to protection from these diseases as from any contagious disease, and for three reasons: first, that the innocent may not suffer; second, that the state may not be compelled to support stunted children; third, that racial degeneracy may be avoided.

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* This paper has been accepted by the Executive Committee of the Section on Ophthalmology of the American Medical Association, to be presented at the St. Louis Session, June 7-10, 1910. Publication rights reserved by the American Medical Association.

In many of these cases of inherited ocular syphilis the lesions or stigmata are so ill-defined as not to be recognizable except by the alert observer. Hence the examination should begin with the new-born infant and should be repeated at brief intervals through early childhood to youth. One reason for this very early examination is to enable us to determine what proportion of these cases of ocular syphilis are actually fetal in origin. The cases of prenatal, intrauterine ocular syphilis, especially of the deeper tissues of the eye, are far more frequent than is usually supposed, and the intrauterine infection runs its destructive course much more rapidly than when the ocular infection develops after birth.

It is a mistake to suppose that congenital syphilitic lesions of the eye run a mild course, for, while some of these syphilitic infants are still-born or die in early infancy, in many of the so-called bad cases the children live through infancy and childhood, but with very extensive ocular and aural stigmata. The ocular lesions may be confined to the lids and conjunctiva or cornea, or they may involve any or all of the deeper structures of the eye. My experience has shown me that in very young infants lesions of the uveal tract are more frequent than keratitis, as evidence of congenital syphilis. Iritis at birth is not a very uncommon lesion, and, while it may exist alone, it is more commonly associated with chorioiditis. It is not always easy of recognition, owing to the external symptoms being but slightly marked, or because of a coexisting keratitis with corneal opacity, but it should be carefully looked for. When the pupillary space is not blocked by exudation, an ophthalmoscopic examination should be made and a chorioiditis will often be revealed.

I have seen this condition many times in infants at birth, and when found it is always associated with stigmata of defective nutrition and the sign of facial senility. The symptoms are often so slight as to escape casual observation, and this is especially true of the ciliary injection and the free exudation into the field of the pupil. One reason why the lesions of the uveal tract have not been recognized at birth is that the period of their development has been placed later, during the fifth or sixth month of life, and hence their appearance at an earlier period has not been looked for. The lesion may be confined to one eye or involve both, and, like most cases of plastic iritis, it is liable to relapse.

The prognosis as to vision is largely influenced by the coexistence of other ocular stigmata, and also by the degree of severity of the syphilitic saturation; and this, I believe, to vary in proportion with the length of the period which has elapsed since the parents contracted the disease, and also with the fact of one or both parents being infected.

These lesions of the uveal tract in very young infants can usually be recognized, however, because at this early age interstitial keratitis is very rare. It is probable that the uveitis in infants seriously involves the retina, but, as most of these unfortunate children die in infancy or early childhood, no proper test of vision can be made.

When the disease occurs later in child life, I am inclined to think that the retina suffers but slightly, for I have examined a number of cases of extensive chorioiditis which I have followed from the initial appearance of the lesion to an age when vision could be tested, and have been particularly impressed by the extremely good visual acuity existing after a very extensive chorioiditis. This disproportion between the actual condition of the chorioid and the existing visual acuity is a very striking feature. But I have never observed this in those cases of the prenatal or infantile chorioiditis who lived to reach the age of childhood when the vision could be tested.

This disproportion between the ophthalmoscopic findings and the actual visual acuity in the chorioiditis of childhood does not exist in the cases of retinitis and optic neuritis. The retinitis due to inherited syphilis in infants and young children seems always to lead to permanent changes in the retina, varying from faint white lines along the smaller arterial branches to entire obliteration of the vessels. In optic neuritis in these very young patients, the end is, in my experience, partial or complete atrophy. It is probable that of all inherited morbid tendencies the inherited syphilitic taint is encountered the most frequently in all classes of life, and the stigmata are extremely variable in number and degree, and often most elusive. In a family of syphilitics there is often a marked difference in the extent and number of the stigmata. There may be many stigmata in different parts of the body, or there may be but a single, well-marked stigma. Some of the stigmata may be so slight and elusive as to escape all but the keenest observation. There may be a history of some serious ocular inflammation pointing to interstitial keratitis or iritis, and yet examination shows a smooth unclouded cornea and an apparently normal iris. But, if we search very carefully, we will find some very slight deformity in the pupillary margin, or some irregularity in the shape of the cornea, usually a malformation of the oval type. The coincidence of interstitial keratitis and a vertically oval cornea is not infrequently observed, and I have noted it for years. Recently Fuchs called attention to it in an admirable short paper read before the British Medical Association in July, 1909.[1] The disease may exist in one eye only, but is usually found in both eyes. If attention is attracted by the corneal malformation in a patient, a more careful examination will reveal traces of very faint opacities, the remains of former interstitial keratitis, which were not suspected. Fuchs is inclined to believe that an oval cornea is much more frequent in cases of inherited syphilis, and especially in those patients in whom interstitial keratitis has occurred or may be expected to occur than in other patients.

This malformation of the cornea, however, like other stigmata of inherited syphilis, should not, when considered alone, be regarded as absolute proof of the disease. We must look for the stigmata in all cases, even when there is no positive evidence of ocular disease. As this paper is restricted to a consideration of the lesions and stigmata in young children, we cannot expect much assistance from the dental stigmata, as the permanent teeth are not yet in evidence, but the ocular and aural stigmata are to be found when carefully looked for.

As regards the aural stigmata the first question is as to the occurrence of any pain, inflammation or discharge from the ears, acute or chronic, in infancy or very early childhood. Examination of the ears will then reveal scars or persisting perforations of the membrana tympani, or more or less complete destruction of the ossicula. If these are not found, then the hearing is to be tested for functional disturbance, though not much can be expected from these tests. But there is a variety of aural trouble without appreciable lesion, which is occasionally found in young children, known as *"surdité foudroyante,"* which is undoubtedly due to inherited syphilis. As is well known, this is characterized by the great suddenness of its invasion, rapid course and intensity, ending in total loss of hearing in a few days or hours without any visible clinical evidence. Such an attack coming on unheralded in a child with apparently normal hearing is almost pathognomonic of inherited syphilis. This condition resists all treatment, and the patient remains permanently deaf. As a natural result of such attacks coming on in early childhood, there may be noticed certain defects of speech, varying in degree to actual mutism.

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[1] Ophthalmic Rev., September, 1909.

The ocular or aural stigmata are often accompanied by facial stigmata, especially on the forehead or nose, often so slight as not to be noticed. In infants and young children the actual congenital malformations are rare, and in themselves are not so significant as the acquired malformations. They consist in flattening and broadening at the base of the nose, just beneath the frontal spine, or in what is known as "snubnose," in which the bridge or line of the nose, instead of presenting a straight or slightly undulating line, assumes a concave or re-entering curve. Further confirmatory evidence of the syphilitic origin of the ocular stigmata may often be found in various congenital cranial stigmata, with which we are all familiar. There are certain conditions found in the teeth of the first dentition which are strongly suggestive of inherited syphilis. One of these is microdontism, in which some of the teeth are very small, while others are of normal size, and this condition is almost entirely in the upper and lower incisors. The difference in size is sometimes so slight as to escape all but the closest observation.

Another condition which I have noted in many children with inherited syphilis, and on which Fournier lays great stress, is the persistence or permanence of the first teeth far beyond the usual period, thus vitiating the development of the permanent teeth. These two dental conditions in very young children often aid in establishing or confirming our diagnosis.

In studying any series of cases we should try to examine the real significance and value of the stigmata presented as aids to diagnosis of inherited syphilis. In the case of the existence of only one stigma, if the examination of other members of the family reveals the presence of other stigmata, then the one stigma points to the correct diagnosis of inherited syphilis. As before stated, it is not uncommon for syphilitic infants to be born with already well-marked evidence of disease of the uveal tract. This is an additional proof that the fetus *in utero* may suffer from inherited syphilis, and yet be born at the full term and live.

As regards the internal lesions of the eye, I believe their apparent rarity is due to the fact that the external evidences are often but slightly marked, and therefore they have not been looked for.

It is a paramount necessity to recognize the stigmata at the very earliest stage, if we are to do anything for the restoration of useful vision; and to recognize them we must look for them. I have recently had under my care a female infant, aged 11 months, with complete posterior synechiæ in both eyes, and a thin membrane filling the pupillary space. The iris bulged toward the cornea, there was increased tension, all pointing to the future development of infantile glaucoma or buphthalmus. An iridectomy was done in each eye and the glaucomatous tendency was arrested, at least temporarily. The ophthalmoscope showed a transparent lens and well-marked signs of a previous chorioiditis.

In conclusion, I would again call attention briefly to the therapeutic deductions which Fournier has drawn from his immense clinical experience, and quoted by me in a paper published two years ago. Fournier lays down four propositions, as follows:

1. Specific treatment is indicated in all cases in which patients are actually affected by lesions or symptoms which might be due to syphilis, and who show at least one of the stigmata mentioned.

2. If a patient shows one or more of the stigmata mentioned, he should be subjected to specific treatment as a prophylactic measure, if there be no actual lesion present.

3. In a recognized syphilitic family, if a child has recently been born who presents one or more of the stigmata, the parents should be submitted to prolonged specific treatment, in order to prevent, if possible, the transmission of the taint to any future children.

4. In case a woman becomes pregnant in a family in which the children previously born show some of the stigmata above mentioned, she is to be subjected to rigid specific treatment during her entire pregnancy.

In view of the many serious, even disastrous, ocular lesions which have come under my observation, I am strongly inclined to add a fifth proposition to the four suggested by Fournier, viz.: that the adult syphilitic should be rendered sterile by surgical interference in order that the disease may not be transmitted to future generations.

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MEMORANDA

THE INDUCTION OF SPINAL ANESTHESIA BY VARIOUS SOLUTIONS

WITH A REPORT OF FIVE CASES *

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Surgical anesthesia produced by lumbar puncture and injection of various local anesthetics (so-called spinal or lumbar anesthesia) is now not only a well-accredited procedure, but one of daily performance in many of the hospitals in the United States. Bier,[1] O. Fürster,[2] and Jennesco,[3] in Europe, and Wayne Babcock,[4] in this country, as well as many other writers, have pointed out the advantages and contraindications for the procedure. All these authors have alluded to some form of ocular palsy as one of the rare complications of this method of surgical anesthesia. I have, therefore, thought it wise to place on record five instances of such complications and to assemble such other recorded instances as have appeared in the literature.

There have been 2,000 lumbar anesthesias induced at the Samaritan Hospital in Philadelphia. Of this number, about 1,400 patients were anesthetized in the service of Dr. W. Wayne Babcock, surgeon to the hospital. About 400 were anesthetized in the service of Dr. William A. Steel, genito-urinary surgeon to the hospital, and 100 more in the service of Dr. Collier Martin, proctologist to the hospital, and Dr. J. C. Applegate, obstetrician to the hospital. Four of the reported cases of resulting palsy occurred in the department of general surgery and

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[1] Bier: Ueber den jetzigen Stand der Rückenmarks Anesthesie, Verhandl. d. deutsch. Gesellsch. f. Chir., 1905.

[2] Fürster, O.: Erfahrungen über Spinalanalgesie, Beitr. zur klinische Chirurgie, xlvi.

[3] Jonnesco: Am. Jour. Surg., 1910.

[4] Babcock, W.: Med. Jour., August, 1909.

one in the department of proctology. This would make a proportion of one in 400 cases. Ach[5] observed four instances of ocular palsy in 400 instances of lumbar anesthesia, a proportion of exactly 1 in 100.

The five cases to be reported follow. They all occurred in the wards of the Samaritan Hospital:

Case 1.—B. A., male, aged 42, admitted to the surgical ward of the Samaritan Hospital, May 15, 1908, for an operation for hemorrhoids, was a Russian Jew in good general health. The anesthesia and operation were without incident. Twelve days after the operation the patient was referred to the ophthalmic out-patient department because of double vision. On examination it was found that the two external recti were involved about equally. Rotation 15 degrees from the median line either to the right or left produced homonymyous diplopia. The eyes were otherwise normal anteriorly and the eyegrounds presented no anomalies whatever. The history was negative as to syphilis or any dyscrasia that might give rise to the palsy. Blood-pressure was found normal. The patient was treated with pilocarpin sweats and biniodid of mercury but there was only slight amelioration in the symptoms. He finally recovered so that he could carry either eye 25 degrees from the median line without seeing double. At this juncture he went to his home and has been entirely lost sight of. The palsy, which appeared twelve days after the spinal anesthesia, lasted at least four weeks and in all probability from six to eight weeks longer, judging from the slow progress made during the four weeks the patient remained under observation.

Case 2.—J. E., a girl, aged 16, had received spinal anesthesia (6.5 cgm. of stovain solution), for appendectomy, July 26, 1909. October 28 she was referred to the out-patient department of the Samaritan Hospital because of headache, vertigo, and double vision. The latter symptoms she claimed to have suffered from for only four weeks, so that, according to her statement, the palsy did not appear until eight weeks after the operation, which is at least four weeks longer than any other case which I have found in the literature. She was found to have vision of 5/7 in the right eye and 5/9 in the left eye; the eyegrounds were normal in every way. There were no stigmata of hysteria that could be elicited. Both external recti were involved as in the previous case, the diplopia beginning about 10° temporalward from the median line. In view of the fact that the palsy seemed undoubtedly due to the spinal anesthetization alone, it was decided in this case to allow Nature to take its course. The object was, of course, to observe whether spontaneous resolution would occur and how long it

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[5] Ach: München. med. Wchnschr., 1907, No. 13.

would take. One month later the diplopia was not in evidence except at the extreme temporal periphery of both motor fields, but this condition still obtained 6 months after the operation.

Case 3.—X. Y., male, aged 24, had received spinal anesthesia (6.5 cgm. of stovain in solution) for appendectomy. On the seventh day the patient began to complain of blurred vision and it was found that diplopia was present, the left exterus being involved. The patient attributed his disturbance of vision to the fact that he had been reading almost all day during his convalescence. The palsy lasted about one week, but the patient states that for two weeks after the double vision had practically disappeared, he could bring on temporary diplopia by reading steadily for from two to three hours. The refractive status was low myopia and myopic astigmatism being:

R. — 1.00s — 50 cyl. 45° = 5/5
L. — 1.00s — 50 cyl. 135° = 5/5

There was no abnormality in either eyeground. Four weeks after the operation the patient was in very good health, the ocular rotations were smooth and complete in all merdians and the muscle balance absolutely normal.

Case 4.—A private case in the practice of Dr. W. Wayne Babcock, occurred in an apparently healthy man, 40 years of age, in whom 6.5 cgm. of a 4 per cent. solution of tropococain dissolved in 10 per cent. alcohol was used. Again it was the externus that was involved, this time only one being affected. The palsy appeared about ten days after the spinal anesthetization, and was of two weeks' duration.

Case 5.—Miss M. D., aged 19, operated on Feb. 19, 1910, for appendicitis, had received 7 cgm. of stovain intraspinally. The patient did very well and recovery was interrupted by no untoward incident, but on the seventh day after operation she began to complain of double vision and it was found that she had concomitant squint. The left external rectus is palsied at the present writing (five days after the first observation) and that eye cannot be carried beyond the median line. The vision equals 5/7 in the right eye and 5/9 in the left eye. The patient's refraction status is: + 1.50 sph. 1.25 cylinder, axis 90° in both eyes. The accommodative near point is 7 inches in each eye; that is to say, that there are 5.5 diopters of accommodation present as against the normal 10 diopters the patient should have at 19 years of age. This completes the picture of cyloplegia and weakening of the externi as it is so often observed during post-diphtheritic palsies.

The cases recorded in the literature may be arranged in three groups, according as they show involvement of one abducens, both abducens, or the trochlearis and oculomotor in addition to the abducens.

GROUP I: ONE ABDUCENS

Hermes[6] notes a case in which the abducens was involved.

In Deetz's case[7] one abducens became palsied thirteen days after stovainization.

Both of Rausscher's cases[8] showed but one abducens of fault after the use of scopolamin 0.06, morphin 0.08 (presumably generally) and stovain, intraspinally (dose not noted). In the one case the palsy ensued on the eighth day, in the other one on the thirteenth day. Both patients eventually recovered.

In one of the instances recorded by Loeser,[9] left abducens, palsy made itself manifest twelve days after lumbar anesthesia for an operation for ovarian abscess in a 35-year-old married woman. The duration of the palsy was twelve days.

Blanluet and Caron's report,[19] concerns a 51-year-old man in whom the spinal anesthesia was induced for an operation for hemorrhoids. Seven minims of a 10 per cent. solution of stovain were used. Diplopia was first noted ten days after the operation, and there was still paresis of the left externus six weeks later at the time of the report.

One of Schmidt-Rimpler's[11] cases is peculiarly interesting in that a permanent concomitant convergent strabismus remained in the eye with the palsied muscle. The transition into concomitant squint was no doubt fostered by the presence of a very considerable hypermetropia with full visual acuity in both eyes. He puts on record another unilateral case[11] in which recovery occurred.

No such fortunate result is recorded in Adam's case[12] of a 33-year-old man on whom stovain was used for a hernia operation. Twenty days later left abducens palsy was in evidence and was quite as pronounced three months later when Adam reported the case. The final outcome is not known. He also records[13] unilateral palsies, one following the use of stovain in a 26-year-old man, the other following the use of novocain in a 27-year-old woman. Recovery ensued in both cases.

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[6] Hermes: Med. Klin., 1906.
[7] Deetz: München. med. Wchnschr., 1906, No. 28.
[8] Rausscher: München. med. Wchnschr., 1906.
[9] Loeser: Med. Klin., 1906, No. 10.
[10] Blanluet and Caron: Rec. d'opth., December, 1906.
[11] Schmidt-Rimpler: Klin. Monatsh. f. Augenh., July, 1907.
[12] Adam: München. med. Wchnschr., 1906.
[13] Adam: Deutsch. med. Wchnschr., 1906.

Schöler[14] has seen one case after stovain in which chloroform was later necessary to complete the operation, the right externus being involved.

Feilchenfeld,[15] too, has seen two cases of unilateral abducens palsy after stovain, one presenting palsy after four months.

In Vossius'[16] case, a 60-year-old woman (stovain), the palsy persisted after six months.

In Lang's case,[17] on the other hand, that of a 41-year-old man (novocain), recovery was prompt.

Scheppens[18] observed paralysis of the left abducens after intraspinal injection of cocain. It is asserted by this author that the left abducens is the one most frequently affected.

Mühsam[19] records two cases, one in a 26-year-old man in whom 15 cgm. of novocain had been used. Palsy of the right externus ensued and disappeared twenty-one days later. The other was a 27-year-old woman in whom novocain and adrenalin were used, but chloroform had to be added, as the anesthesia was imperfect. This patient also exhibited palsy of the right externus (four days after operation), which lasted twenty-two days.

To this list should be added Cases 3, 4 and 5 reported at the beginning of this paper.

GROUP II. BILATERAL CASES

Lang[20] puts on record an instance of bilateral abducens palsy as seen in a 61-year-old man in whom lumbar anesthesia was induced with novocain and adrenalin. The palsy appeared on the right side eleven days, on the left side thirty days after operation, and persisted at the time of the report of the case some months later.

Baisch[21] also has seen a bilateral case following the intraspinal use of alypin. The diplopia was of but five days' duration.

In Goetermann's case[22] tropacocain and adrenalin were used. Eight days later palsy of both abducens was noted, and is ascribed by the reporter to some toxic influence exerted on the nucleus.

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14. **Schöler**: Soc. d'ophth. de Berlin, 1906.
15. **Feilchenfeld**: Centralbl. f. prakt. Augenh., 1906.
16. **Vossius**: Med. Gesellsch. Giessen, 1906.
17. **Lang**: Deutsch. med. Wchnschr., 1906.
18. **Scheppens**: Clin. Opht., Nov. 25, 1908.
19. **Mühsam**: Deutsch. med. Wchnschr., 1906.
20. **Lang**: Deutsch. med. Wchnschr., 1906.
21. **Baisch**: München med. Wchnschr., 1906.
22. **Goetermann**: Berl. klin. Wchnschr., 1908, No. 28.

Novocain and suprarenin were used in Landow's case.[23] Chloroform also had to be added to secure complete anesthesia. The ocular condition developed seven days after operation, and was accompanied by severe cephalalgia and pain in the cervical region. Recovery eventually ensued.

Ach's four cases[24] were encountered in 400 cases of spinal anesthesia.

To these cases should be added Cases 1 and 2, reported at the beginning of this paper.

GROUP III: CASES SHOWING INVOLVEMENT OF OTHER MUSCLES THAN THE ABDUCENS

Mingazini[25] observed almost complete bilateral ophthalmoplegia externa in a youth of 16 thirteen days after spinal anesthesia for varicocele. To the oculomuscular condition was added paralysis of the velum palati, of the constrictor of the eyelids, of the muscles of mastication and finally sensitivo-sensorial hypesthesia on the left side. The muscles of the extremities were also weakened. This complexus of symptoms corresponds to pseudoparalytic myasthenia gravis, but it is also to be noted that the youth showed pronounced hereditarily neurotic tendencies for more than a year before the spinal anesthesia was induced.

In Becker's case[26] there was palsy of the third nerve as well as of the abducens (incomplete unilateral ophthalmoplegia externa) eleven days after intraspinal use of 6 cgm. of stovain, the palsy being of four weeks' duration.

Loeser[9] reports the only case so far on record of palsy of the superior oblique. It occurred twelve days after novocain had been used. Six months later recovery was complete.

Analysis of the table which brings together all the cases that could be found in the literature indicates the following points to be considered:

I. The alkaloid used.
II. The dose.
III. The muscle affected.
IV. The interval between the spinal anesthesia and the appearance of the palsy.

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[23] Landow: München. med. Wchnschr., July 24, 1906.
[24] Ach: München. med. Wchnschr., liv.
[25] Mingazini: Rev. Neurol., March 15, 1908.
[26] Becker: München. med. Wchnschr., 1906, No. 28.

V. The duration of the palsy and the frequency of recovery.

VI. The pathogenesis of the condition.

VII. The frequency with which the surgeon may expect it to occur as a complication.

I. THE ALKALOID USED

A glance at the table will show that nearly every local anesthetic has been employed, stovain leading the list. In the order of frequency of use in this series they are as follows: stovain twenty-one times, novocain six times, tropacocain three times and cocain and alypin each once. In four cases it is not known what anesthetic was used. W. Wayne Babcock, in a private communication, informs me that he has also used eucain and cocain lactate. While some of the continental surgeons have claimed a certain selective affinity of some one of the agents named for certain of the nuclei governing the ocular muscles, there is nothing in the facts to support the contention.

II. THE DOSE EMPLOYED

Unfortunately this factor has not been sufficiently often set down in the literature to make it as yet of much value. Judging from the few instances in which the dose is stated, it would seem that continental surgeons are rather given to doses ranging from 10 to 15 cgm., while American surgeons lean toward smaller dosage, 5 to 7 cgm. being the amount usually introduced into the spinal canal. This may have something to do with the seemingly slighter frequency of ocular palsies as a complication of spinal analgesia as seen in this country; but this point will be alluded to later on.

III. THE MUSCLE OR MUSCLES INVOLVED

It is a noteworthy fact that of the thirty-six cases that have been brought together thirty-three showed involvement of the external recti alone. Two exhibited incomplete ophthalmoplegia externa and one presented fourth-nerve palsy.

IV. THE INTERVAL BETWEEN THE PRODUCTION OF THE SPINAL ANALGESIA AND THE ONSET OF THE PALSY

In the twenty-seven cases in which the time of onset of the palsy is noted, the average time of onset was ten days after the spinal analgesia was induced. In two cases the interval was but four days (Mühsam, novocain-analgesia, and Ach, stovain-analgesia) and in another five days (Loeser, novocain-analgesia) and in another six days (Vossius—no note as to which analgesia was used). Inasmuch as the great majority of the remaining operations reported were done under stovain, it would rather appear that novocain predisposes to earlier onset of the ocular palsies, when they do occur, than the other analgesic agents employed for this purpose. Over against this seeming argument stands the contradictory findings in Lang's case[20] in which 15 cgm. of novocain were used intraspinally and the palsy did not appear in the right eye until the eleventh day and in the left eye until the thirtieth day! Whereas in Vossius' case, above referred to, but 8 cgm. of novocain were used with but four days' interval between the use of the anesthetic and the onset of the palsy. Plainly, some other factors must be at work. With these I shall deal when discussing the pathogenesis of these palsies.

V. THE DURATION OF THE PALSY AND FREQUENCY OF RECOVERY

There is much uncertainty about this phase of the matter. In twenty-six cases in which this datum is alluded to, five seem to have been transitory, as the duration was but from five to six days and the patient was very little if at all inconvenienced thereby. In one case eight days elapsed before single vision ensued, in another twelve and in three others twenty-one, twenty-two and twenty-three days, respectively. In one case recovery is noted after six months and in another after eight months; but in five at least the palsy seemed as fixed at the time of report of the case as it was at first.

In all, sixteen positive recoveries are recorded in twenty-six cases that were watched, although one of them, as stated, was eight months in achieving single vision. It would, therefore, appear that a certain small percentage (as yet unfixed) will exhibit some form of permanent ocular palsy as one of serious complications of spinal analgesia.

VI. THE PATHOGENESIS OF SUCH PALSIES

The pathogenesis of these palsies is not clear. Adam[12] quotes Oppenheim in his opinion that tiny nuclear hemorrhages are the cause of such palsies, and Kalt,[27] in the discussion of Blanluet and Caron's case, asked whether the symptoms might not have been due to an ordinary hemorrhage which took place at the time of injection. The argument, however, does not explain the usual interval of eight to ten days between the spinal anesthetization and the onset of the palsy. To meet this particular objection Müller[28] suggests that these palsies may be due to inflammation in consequence of overstretching or crushing suffered by the nucleus or nerve during or after the sudden outflow of the cerebrospinal fluid. Blanluet and Caron[10] are seemingly much of the same mind, for they feel that we cannot lightly put aside the idea of an infectious meningitis in such cases. They further urge that a subsequent lumbar puncture done with the idea of examination of the cerebrospinal fluid be performed at the same time such palsies occur. The facts that these palsies are frequently one-sided seems to them to exclude the possibility of toxemia which generally produces bilateral phenomena (see Babcock's remarks following).

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[27] Kalt: Ophthalmic Year-Book, 1907, p. 95.

The superficial position of the abducens nucleus in the fourth ventricle is advanced by Schmidt-Rimpler[11] as the most probable reason for the frequent involvement of the muscles supplied by the sixth nerve. The fourth ventricle communicates through the foramen of Majendie and the lateral apertures with the arachnoid space of the cord which contains the anesthetizing fluid. Involment of the roots of the vagus and glossopharyngeus which have likewise a superficial position are not rare in lumbar anesthesia. The fact that these particular palsies do not occur until about eight to ten days after the spinal anesthesia has been advanced, says Schmidt-Rimpler, is an objection to the above hypothesis, but (he goes on to say) "we observe an analogy in the delayed effect of the diphtheria toxins on the ocular nerves which also do not generally occur until several weeks after the recovery from the primary disease." Ach[24] evidently has just some such idea in mind when he made his experiments on eighteen rabbits to learn whether colored fluids injected into the spinal canal do really reach the base of the brain. He quotes Quincke, Jacob, and Crile, all of whom assert that colored fluids do rapidly reach the basis cerebri; but Ach could get no such results himself. Braun (quoted by Ach) contends that animal experimentation has only lent confusion to our ideas on this subject. Ach feels that stovain is the offending substance and should be avoided. He also counsels that patients should remain in a semirecumbent position with the shoulders raised for some time after the injections. Feilchenfeld[15] goes further than Ach in his belief that stovain is the chief offending substance and holds that there is an elective affinity of the various anesthetic substances for the various tissues and nuclei in the fourth ventricle. He even goes so far as to assert that stovain is most likely to produce abducens palsy, while novocain selects the trochlearis for its special action! A glance at the accompanying table will show that of the six times novocain was used for spinal analgesia it produced trochlearis palsy once and abducens palsy five times; so that his theory meets with no support from the facts.

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[28] Müller: Ztschr. f. Augenh., April, 1908.

Pechin,[29] in discussing Blanleut and Caron's case, remarked that it was possible for the liquid injected to have reached the higher centers by diffusion and thus come in contact with the sixth nerve nuclei. In the case reported, he was inclined to view the oculomuscular disturbance as of labyrinthine origin, from the presence of the drug in the cerebrospinal liquid bathing the ampulla. Bonnier,[30] too, urges that the intimate relation which exists between irritation of the labyrinth and oculomuscular disturbances has not been sufficiently recognized. He points out that it is only recently that the association between otitis and palsy of the sixth nerve has become well known (Gradenigo's syndrome), although many authors have called attention to the association. Bonnier thinks that the connection between oculomuscular disturbance and labyrinthine disease is as frequent as such association between the former and affections of the globe is rare. He believes that this gives the clue to the explanation of the occurrence of oculomuscular disturbance after spinal anesthetization. The fluid injected reaches the cavity of the labyrinth and there comes into the closest contact with the nervous mechanism of the ear, which involves a motor nerve of the eye, the sixth being most frequently affected.

W. Wayne Babcock has still another theory to account for these palsies; and, as he has personally induced

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[29] Pechin: Ophthalmic Year-Book, 1907, p. 96.
[30] Bonnier: Ann. d'Ocul., July, 1907, p. 67.

Reporter.	Reference.	Age.	Sex.	Alkaloid Used.	Dose. Cgm.	Muscles Affected.	Time After Operation Palsy Appeared. Days.	Duration of Palsy.	Result.
Loeser	Med. Klin., 1906, No. 10	45	M.	Novocain,	?	L. sup. oblique	5	6 mos.	Recovery.
Loeser	Med. Klin., 1906, No. 10	25	F.	Stovain	?	L. ext. rect.	8	8 mos.	Recovery.
Schoeler	Soc. d'Opht. de Berlin, 1906	?	?	Stovain	?	R. ext. rect.	8	?	?
Feilchenfeld	Centralb. f. prakt. Augenh., 1906	?	?	Stovain	?	L. ext. rect.	12	?	?
Feilchenfeld	Centralb. f. prakt. Augenh., 1906	?	?	Stovain	?	L. ext. rect.	?	?	?
C. Adam	München. Med. Wchnschr., 1906	33	M.	Stovain	?	L. ext. rect.	20	3 mos.	Still palsied at time of report.
Mühsam	Deutsch Med. Wchnschr., 1906	26	M.	Stovain	15	R. ext. rect.	10	21 days.	Recovery.
Mühsam	Deutsch Med. Wchnschr.. 1906	27	F.	Novocain	8	R. ext. rect.	4	22 days.	Recovery.
Lang	Deutsch Med. Wchnschr., 1906	61	M.	Novocain	15	Both ext. rect	R. 11 L. 30	?	Persisted at time of report.
Lang	Deutsch Med. Wchnschr., 1906	41	M.	Novocain,	?	L. ext. rect.	11	5 days.	Recovery.
Vossius	Med. Gesellsch. Giesen, 1906	60	F.	?	?	L. ext. rect.	6	?	Persisted after 6 months.
Blanluet and Caron.	Soc. d'Opht. de Paris, 1906	51	M.	Stovain	5	L. ext. rect.	9	?	Persisted after 6 months.
Hermes	Med. Klin., 1906	?	?	?	?	One ext. rect.	?	?	?
Deetz	München. Med. Wchnschr., 1906, No. 28.	?	?	Stovain	?	One ext. rect.	12	?	?
Rausscher	München. Med. Wchnschr., 1906	?	?	Stovain	?	One ext. rect.	8	?	Recovery.
Rausscher	München. Med. Wchnschr., 1906	?	?	Stovain	?	One ext. rect.	13	?	Recovery.
Loeser	Med. Klin., 1906, No. 10	25	F.	Stovain	?	L. ext. rect.	12	12 days.	Recovery.
Schmidt-Rimpler.	Klin. Monatsbl. f. Augenh., July, 1907.	?	?	?	?	One ext. rect.	?	?	Recovery.
Schmidt-Rimpler.	Klin. Monatsbl. f. Augenh., July, 1907.	?	?	?	?	One ext. rect.	?	?	Palsy persisted.
Adam	Deutsch Med. Wchnschr., 1906	26	M	Stovain	?	One ext. rect.	?	?	Recovery.
Adam	Deutsch Med. Wchnschr., 1906	26	F.	Novocain	?	One ext. rect.	?	?	Recovery.
Scheppens	Clin Opht., Nov. 25, 1908	?	?	Cocain	?	L. ext. rect.	?	?	?
Baisch	München. Med. Wchnschr., 1906.	?	?	Alypin	?	Both ext. rect	?	5 days.	Recovery.
Goetermann	Berl. Klin. Wchnschr., 1908, No. 28	?	?	Tropacocain	?	Both ext. rect.	8	?	?
Landow	München. Med. Wchnschr., 1906	?	?	Novocain	?	Both ext. rect.	7	?	Recovery.
Mingazini	Rev. Neurol., March 15, 1906	16	M.	Stovain	?	Almost complete ophthalmoplegia externa.	13	?	?
Becker	München. Med. Wchnschr., 1906	?	?	Stovain	6	Third nerve and sixth nerve.	11	?	?
Ach	München. Med. Wchnschr., 1907	?	?	Stovain	?	One ext. rect.	8	21 days.	Recovery.
Ach	München. Med. Wchnschr., 1907	?	?	Stovain	?	One ext. rect.	4	43 days.	Recovery.
Ach	München. Med. Wchnschr., 1907	?	?	Stovain	?	One ext. rect.	11	6 days.	Recovery.
Ach	München. Med. Wchnschr., 1907	?	?	Tropacocain	?	One ext. rect.	7	8 days.	Recovery.
Reber	Present report	40	M.	Stovain	6½	Both ext. rect	12	?	Persisted at the time he left hospital.
Reber	Present report	16	F.	Stovain	6½	Both ext. rect.	8 weeks.	6 mos.	Palsy persisted.
Reber	Present report	24	M.	Stovain	6½	L. ext. rect.	7	7 days.	Recovery.
Reber	Present report	35	M.	Tropacocain	6½	One ext. rect.	10	14 days	Recovery.
Reber	Present report	19	F.	Stovain	6½	L. ext. rect.	7	?	Under observation only 3 days at time of report.

nearly 1,500 spinal analgesias, I wrote him in reference to the matter. His reply follows:

> There have now been given by Dr. Steele, Dr. Martin (and his assitants), Dr. Applegate and myself, about 2,000 injections for the production of spinal analgesia. Personally, I have given about 1,400 injections, having used stovain, tropacocain, eucain, cocain lactate, novocain and alypin. Most of the injections have been given with stovain or tropacocain. These analgesics have been given dissolved in water, with or without the addition of sodium chlorid, adrenalin, 10 per cent. alcohol or strychnin. I have had great difficulty in securing uniform solutions, although ampoules of the solution have been prepared for us by German, French and several American chemists, and we have also prepared the solutions extemporaneously. All these local anesthetics seem to share with cocain, though perhaps to a lesser degree, instability in the presence of heat, so that boiling may set free certain undesirable and even toxic substances. I have noticed the clinical evidence of this with cocain in decreased anesthetic action and severe pain after the injections of boiled solutions of this alkaloid for purposes of ordinary local anesthesia. I have seen local necrosis follow the injection of stovain in strong solution in the prepuce. When used for spinal analgesia, boiled stovain solutions give more frequent and more severe secondary headaches (and, at times even stiffness and rigidity of the muscles of the back of the neck) than solutions which have not been exposed to high degrees of heat. Moreover, the solutions which show the greatest untoward after-effects seem to show a deficiency in analgesic power. Similar observations have been made in reference to tropacocain.
>
> Despite considerable correspondence, we have not been able to secure uniform solutions from some of the chemists we have appealed to. One lot of 100 ampullas (Tyndalized) gave excellent anesthesia and were practically free from all secondary effects; the use of another lot would be found deficient in analgesia, with marked secondary headaches and occasional rigidity of the muscles of the back of the neck. Jonnesco, who apparently has recently come to the same conclusion, prepares the solution at the time of each injection, and never subjects the stovain or other substance employed to heat.
>
> Influenced by our investigations showing the marked antiseptic properties of stovain, we have recently been led to dispense with the sterilization of stovain, and a limited use of such extemporized solutions has given us much satisfaction. It has been our custom to discontinue the use of certain lots of ampoules as soon as we determined that they gave rise to frequent secondary headaches or other undesirable phenomena. Occasionally it has happened, however, that others connected with the Samaritan Hospital staff, not knowing that a certain solution had been discarded by us, have once or twice used such

solutions. It was after the use of such a solution (that I had practically condemned) that the first case of ocular palsy in the service of Dr. Martin occurred. A recent case occurred after the receipt of a new lot of ampoules, which we assumed were identical with the satisfactory lot previously used, but which evidently had been more or less decomposed by heat. In the last case, 4 per cent. tropacocain was used, dissolved in 10 per cent. alcohol. It is my belief that in all cases the amount varied between 5 and 8 cgm.. In a number of instances, we have given high injections of tropacocain or stovain, including injections through the seventh cervical or the first dorsal interspace; also we have secured high anesthesia by injecting into the lower dorsal region, solutions of a low specific gravity, with the patient so arranged that the solutions would ascend and affect the upper cord. After none of these injections have we observed ocular or other palsy.

The interesting fact is that all of the four cases in which ocular palsies have been noticed have occurred after injections for analgesia of the lower abdominal segments.

At the present time, I would draw the following conclusions:

1. We have no positive final proof that pure stovain or tropacocain, when used for spinal analgesia will be followed by paralysis of the ocular muscles.
2. The use of solutions of both stovain and tropacocain may be followed by such palsies and by other symptoms suggesting the presence of associated by-products.
3. The palsy may occur irrespective of the use of adrenalin, alcohol, glucose or other admixture, although it is possible that some of these substances may accentuate or favor the undesirable effect.
4. The antiseptic properties of stovain and tropacocain and the fact that in quite a number of instances I have withdrawn cerebrospinal fluid from one to many days after the spinal analgesia, and have never found the slightest turbidity of cellular exudate, or other indication of inflammatory action, inclines me to the belief that sepsis or a bacterial irritation is not responsible for the ocular palsy.
5. An incidence of ocular palsy in one to 400 or 500 spinal analgesias and the occurrence of frequent headaches should make surgeons very careful to avoid heated or decomposed solutions for spinal analgesias.
6. Spinal analgesia should not be discredited by the untoward effects resulting from decomposition or contaminating by-products. Unfortunately, no Squibb has yet arisen to do for spinal analgesics what has been done for ether and chloroform.

It may be interesting to add that I have seen a much greater incidence of brachial and musculospiral palsy after etherization than muscular palsy after spinal analgesia.

The ideas advanced by Babcock seem to me plausible, and it is possible that if this phase of the subject is followed out it may help much to clarify the present confusion concerning the pathogenesis of these palsies. Further investigation of this subject would imply at least two lines of action. First, the most careful polariscopic studies should be made of both boiled and unboiled solutions of the local anesthetics used for spinal analgesia, this to be supplemented by animal experimentation as to toxicity or non-toxicity of heated or boiled solutions as compared with non-heated solutions. At the same time I am deeply impressed with the findings in Case 5, which occurred on the day this paper was to be forwarded to the Secretary of the Section. In this case we have combined the cycloplegia and weakness of the externi so characteristic of the post-diphtheritic toxemias, and it is difficult to put aside the conviction that some form of low-grade toxemia is operative in these cases.

Finally, if, as herein shown, two cases in 2,000 spinal analgesias exhibit, as by-products, ocular palsies of more than three months' duration, it must be admitted by all conservative surgeons that there exists a remote complication of spinal analgesia thus induced that should be taken into account. Whether it be due to the presence of the by-product referred to or to actual anatomic lesions following the use of the analgesic agent, or to some obscure toxemia, remains to be settled.

1212 Spruce Street.

MEMORANDA

MEMORANDA

CATARACT-IN-CAPSULE EXTRACTION BY A NEW MEANS AND A NEW METHOD *

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The ideal operation for cataract is the one that insures the removal of the cloudy lens in its capsule. The means and the method that can make this operation easiest and safest are to be desired. At the meeting of this Section one year ago, while listening to Dr. Greene's paper on the Smith operation, it occurred to me that an instrument could be made that would tear loose the ligaments and make the expulsion of the lens in its capsule easy.

I immediately made a drawing of the newly thought of instrument, and two days later, in Philadelphia, had one made by Ferguson. The accompanying illustration is a perfect representation of the original instrument, which was briefly described in THE JOURNAL last year,[1] and on which, it seems to me, no improvement can be made. As well shown, it is a right- and left-handed instrument. Each end terminates in a double curve, one in line with the handle and the other at right angles to this line, the angle being at the point of union of the two curves. The two curves have the same radius, which approximates that of the anterior surface of the lens, and they are of the same length, not less than 5 nor more than 6 mm. There should be no sharpness at the angle of union of the two curves, nor at the free end of the second, or horizontal, curve. The edges of each curve should be well rounded. If thus made, the manipulation of the instrument will not rupture the capsule while tearing loose the ligamentous attachments. I

*** This paper has been accepted by the Executive Committee of the Section on Ophthalmology of the American Medical Association, to be presented at the St. Louis Session, June 7-10, 1910. Publication rights reserved by the American Medical Association.**

[1] Savage, G. C.: A New Method for Detaching the Cataract in Its Capsule, THE JOURNAL A. M. A., Oct. 9, 1909, liii, 1186.

believe the means to be as perfect for the purpose as is possible. I have named it the cataract-in-capsule detacher.

While my first conception of the instrument was perfect, the method of operating with it was evolved in the course of five operations. I will outline every step of the operation as I now do it, and as I believe it should always be done. Even the steps which are common to all cataract operations, and for which I can claim no credit, may be mentioned in connection with those steps that are peculiar to my operation, and are of my own devising.

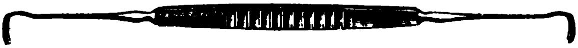
1. After dilatation of the pupil, there should be thorough aseptic preparation of the patient, the instruments, the operator and the assistants.

2. The eye should be completely anesthetized by means of a 4 per cent. solution of cocain, one or two drops every four minutes for three instillations, the operation to begin at the end of another four minutes, or twelve minutes after the first drops. This method of using cocain makes possible a painless operation, in most cases.

3. The lid elevator should be used for controlling the upper lid, and this alone should be done by one assistant, the operator himself inserting the instrument and then placing it in the hand of the assistant, who should be instructed not to allow either the instrument or the lid to come in contact with the globe at any stage of the operation. The assistant should thus hold the lid elevator until the operator, having delivered the cataract, is ready to take the elevator into his own hands for the purpose of gently restoring the lid over the eye.

4. A second assistant, with the index-finger of his left hand placed on the skin of the lower lid, should draw it down gently, but not necessarily very far. In his right hand he should hold the iridectomy scissors, which he may, or may not, be called on to use. This assistant should stand to the right side of the patient, whether the eye be the right or the left, while the other assistant should stand on the side not operated on. The first assistant can be dispensed with entirely if the operator prefers the speculum to the elevator; and the only thing the second assistant would have to be ready for is the use of the iridectomy scissors. But it is safer to use the elevator than to use the speculum.

5. The lids out of the way, the operator, standing always at the head of his patient, should fix the eyeball by firmly grasping the tendon of the internus at its insertion, resting the hand holding the fixation forceps on the opposite side of the face and on the bridge of the nose, so that he may neither pull nor push the eye with the forceps—simply to steady the eye is the purpose. With a Graefe knife, sharp at point and edge, in his other hand, the operator makes the puncture and counter-puncture of the cornea with greater ease because of the character of the fixation, and then completes the incision, which need not include more than five-elevenths of the corneal margin. A conjunctival flap should be made when possible, but always the incision should be upward and in the corneal margin.



Cataract-in-Capsule Detacher.

6. Still grasping the tendon of the internus, the operator lays down the knife and takes up the iris forceps, with which he seizes the iris opposite the center of the corneal incision, and gently drawing it out, directs the assistant to clip it close to the forceps, thus insuring a small iridectomy. (Through several operations I wavered between a small iridectomy and no iridectomy, but have finally settled on the correctness of a small iridectomy. It facilitates the dislodgment and delivery of the lens, and the only objection attending it is the bleeding which sometimes follows the cutting.)

7. Still grasping the tendon of the internus, the operator lays down the iris forceps and takes up the detacher. He easily passes it through the corneal incision, directing the free point into the pupillary opening, and passing it beneath the nasal part of the iris, in contact with the anterior surface of the cataract. The angle of union of the two curves, and the vertical curve itself, are easily passed between the iris and the cataract. When thus passed, the horizontal curve must rest on the cataract about half-way between its center and its lower border, while the vertical curve must rest on the cataract half-way between its center and its temporal border; and both curves must be behind the iris, so that it may not be injured, when the dislodging pressure shall be made. This is the primary position of the

detacher. On two easily executed movements of the detacher depends success in freeing the cataract from its ligaments: First, by rotating the instrument on its long axis outward the vertical curve is made to press the outer edge of the cataract backward, while it makes the inner or nasal edge advance to the same extent. This pressure, when properly made, tears loose the lateral (both temporal and nasal) ligaments, almost from top to bottom. The detacher is now returned to its primary position, and the second movement is effected by advancing the upper end of the instrument in such a way as to make pressure with the horizontal curve. This pushes backward the lower part of the cataract, while it causes the upper margin to advance to the same extent. This tears loose the remaining ligaments above and below, which were not torn by the first rotation. The rotation of the cataract, first on its vertical axis, detaches all lateral ligaments, and second, on its horizontal axis, detaches the ligaments above and below. The two movements together sever the ligaments throughout the entire circle. After the second rotation the detacher is returned to the primary position, and then removed in the reverse order of its introduction.

9. The fixation forceps, having been used while making the corneal incision, while doing the iridectomy, and while using the detacher, must now be laid aside. In one hand the operator now takes the Daviel spoon, with the back of which to make pressure on the lower part of the cornea for the delivery of the detached cataract. In the other hand he takes the cystotome, with the shank of which to make counter-pressure, if necessary, until the cataract begins to emerge, at which moment, while keeping up the pressure, he ceases to make counter-pressure, and with the point of the cystotome transfixes the cataract from behind, and lifts it out of the eye. The moment after transfixion all pressure is removed, thus lessening the risk of escape of vitreous.

10. If any iris is in the wound, it is replaced; the edges of the corneal cut are coapted and the conjunctival flap, if any, is smoothed out. Now the operator takes the lid elevator in his own hand, and gently places the lid in its normal position.

11. The after-treatment is that usually followed, and is directed toward the prevention of infection of the corneal wound and to guard against iritis. Should either

of these conditions arise, as they may after any operation for cataract, they must be vigorously fought with our best and most approved agents.

In the eight months since the detacher became a finished instrument, thirty-eight operations with it have been done in Nashville, nineteen by myself, twelve by Dr. Hilliard Wood, four by Dr. M. M. Cullom, two by Dr. George H. Price, and one by Dr. J. P. Crawford. The cases are too few and the time covered too short to justify a detailed report of results. Suffice it to say that I am satisfied, and that my local confrères share with me this satisfaction. My operation has been honored in its own city, which means much in its favor.

In closing, I may be allowed to make the following claims:

1. The detacher is my own invention.
2. The method of fixing the eyeball through three vital steps of the operation is mine.
3. The method of detaching the cataract is mine.
4. The method of doing the iridectomy is mine.
5. The method of transfixing the cataract, from behind, as it begins to emerge, and lifting it out of the eye, the pressure ceasing after the transfixion, is mine.

Before using my detacher and applying the methods as set forth above, on the human eye, free use should be made of fresh pigs' eyes. On pigs' eyes my operation will not suffer in comparison with the Smith Indian operation, or with any other operation. On the human eye, whether the cataract is ripe or unripe, the operation set forth in this paper is the easiest, the safest and the best.

137 Eighth Ave. N.

MEMORANDA

MY EXPERIENCE IN THE OPERATION FOR CATARACT *

J. L. THOMPSON, M.D.
INDIANAPOLIS

As so much is being written on the extraction of the lens in its capsule by those who number their operations by thousands, as do some operators in India, a few words may not be out of place by one who belongs to the large majority of operators in this country who cannot truthfully report forty cases in one year. I shall mention, therefore, some of the dangers which have beset my path, not in the more difficult operation above mentioned, but in the methods of extraction as usually made.

After practicing medicine and surgery in private, and as surgeon in the army for nearly three years during the civil war, I studied eye diseases under the late Dr. E. Williams of Cincinnati in 1867, and entered his office later as his assistant. Dr. Williams, according to the late Dr. Samuel D. Gross of Philadelphia, was the first regular physician in the United States to make eye diseases a specialty. Others treated eyes long before his day, but they practiced medicine and surgery also. While with Dr. Williams I took the names and records of every patient on whom he operated for cataract (and have them still) and they number but fifty-two in one year. His patients were very numerous; they came from our northern lake region to the Gulf of Mexico; from near Pittsburg to the Rocky Mountains. And it should be remembered that eye specialists were comparatively few in those days; now they are almost as numerous as laparotomists.

When in 1871 I located in Indianapolis there was but one regular practitioner who did much eye work, but he

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did not confine his practice thereto; nor did I know of another in the state. Now I know of no town in the state with a population of fifteen thousand that has not two or more specialists on eye, ear, nose and throat. From these figures how many do you suppose extract fifteen cataracts in one year? Would such men dare to extract the lens in its capsule?

The late Dr. George C. Harlan of Philadelphia tersely described the necessary qualifications of an eye surgeon as follows: "He must have good vision, a steady hand, coolness and judgment in difficulties and a full appreciation of his responsibilities." Other eminent men have added that he should cultivate ambidexterity, and by all means practice medicine and surgery for several years; then study under a master in eye work before beginning this highly important specialty.

Senile cataract (as the name implies) usually occurs in elderly persons; hence the importance of a very careful investigation as to the general physical condition of the patient before operation. Thirty-three years ago I operated on a farmer whose health seemed to be excellent, and he so reported it. The combined extraction was made; the man did well; on the twelfth day he could read ordinary print with a plus glass; but on the fourteenth day he had a severe chill, followed by a high fever with vomiting; this continued for some days and started an inflammation of the uveal tract, which caused the loss of his eye. Unfortunately he had failed to inform me that he had suffered from malarial fever the previous autumn. Three years later the lens of his remaining eye was ripe, when I made a preliminary iridectomy, and extracted it two months later, but before doing so satisfied myself that he was in no danger from malarial poison. The man is now past his eightieth year and can see to read very nicely. I encountered a stimilar case a few years after. A woman not 50 years old was brought to me by a physician from a neighboring town for operation. He reported her health as being the best. Her eye was examined in every way and found to be in favorable condition for operation. The extraction was done and the woman did well until the seventh day; then, when I called to dress the eye, she was raving, had torn the bandage off, and declared that the woman who kept the boarding house was trying to poison her. She grasped my wrists and said that she would not release me until I took her from the house. With the help of a physician she was taken to a hospital, where she died in a few days from typhoid fever. I learned soon afterward that before she came she had been nursing her husband through a very severe illness from the same disease, and that she had made him promise that as soon as he was better he would have her cataract removed.

One other patient I must mention. A farmer, over 70, was operated on and did well until the tenth day, when he complained of a severe pain in the calf of his leg on the opposite side to the diseased eye; in a few days the limb became cold, gangrene soon came on and the leg was amputated. When the surgeon removed the tourniquet no arteries required ligation, as they were calcareous. The man died in a few weeks. Some of his friends said that the operation for cataract caused the trouble in the leg. Others said "No," as it was on the opposite side. These cases show the importance of a thorough physical examination before cataract extraction.

I have had very poor ultimate results in patients addicted to the use of whiskey ten or more times a day for years. The operation may be faultless and the sight very good for a short time, but congestions and subacute inflammations hang on so long that vision is much impaired and often lost.

Women who suffer much for years after the menopause with flushed faces and eyes are not good subjects for cataract extraction. One of these is now under my care. She was operated on by the combined method two months ago, went home able to read, and was given my usual instruction to be very careful in no way to expose the eye for four weeks. When she reached home she found her husband very ill with appendicitis, from which he died. She was up with him night and day for ten days, getting but little sleep. I saw her one month afterward, with vision only 6/cc. I used the fluidextract of ergot internally, and her vision, she reports, is much better. Ergot has accomplished much in several of these patients.

In 1895 a retired capitalist from a distant city, who was blind in both eyes, was operated on—simple extraction. He did well and was ready and dressed for the train when he fell to the floor of the hospital and was unconscious for a short time; he was taken home on the following day and died shortly afterward. A dear old lady, aged 70 years and blind in both eyes, had a similar result after a simple extraction. When her husband and daughter came to take her home I put a glass on her to show the family that she could read; they were delighted, but their joy was soon turned to mourning. She was about to step into the carriage, fell to the pavement and was taken back to the hospital, where she died in one hour.

These cases depress one very much, and it is impossible to convince the friends and relatives that the operation was not the cause of death. I recall two simple cataract extractions in large fleshy women, both of whom had profuse retinal hemorrhage after faultless operations, and after the bandages were applied, and the patients were in bed; of course the eyes were lost.

I cannot conceive of anything which makes the operator feel worse than do these unlooked for results which so injure his reputation.

Three of my patients became maniacal in from two to five days after the extraction; they tore the bandages from their eyes and raised quite a disturbance; two of these were women, one a vivacious Irishman; I looked for bad results, but they did well. Some patients have been troubled with illusions and hallucinations. One of these was the wife of a poor physician in a small town, well educated and very fond of books; she had been blind for several years and had led a lonely life. I made a simple extraction on one eye, which gave her excellent vision. Some time after she returned home and found that she could read fine print; she was so happy that it slightly unbalanced her mind. She then sent to inquire of me if I ever prescribed glasses which enabled my patients to see their friends in the spirit world, as she did. What a gift this would be!

Others I have treated have returned home in two or three weeks delighted with their improved vision, but a few weeks later letters have been received concerning their failing sight, and when they came to me later I have found inflammation of the chorioid which, in spite of all treatment, has ended in blindness. Others have not only lost the eye from which the cataract was removed, but also the second eye from sympathetic iridochorioiditis.

Glaucoma is another dread monster which has occasionally attacked my patients years after a successful extraction resulting in good reading vision. I now have a patient, a woman, aged nearly 70, from whose left eye I made a simple extraction seven years ago, and did the same on the right eye nearly four years after. She had very white hair and light, soft blue eyes, the pupils were so round and natural that no one could see that an operation had been made. I felt very much pleased with the result, as did the patient. Recently she came to see me when I found the right eye very hard and the vision reduced to 10/cc. Myotics failed to reduce the tension and, to my great regret, an iridectomy had to be made. The eye is now better, vision is 16/c, but as to the ultimate result time alone can tell. Other patients have had hyalitis with dense floating bodies in the vitreous, some have suffered from chorioidal and retinal exudates and hemorrhages many years after ideal extractions. All operators long engaged in this work must have had many like results.

For ten or more years I operated on both eyes if everything was favorable and the patient desired it. One of these patients was a farmer, aged nearly 88, tall, wiry-looking, straight as an arrow, who was a soldier in the war of 1812. His eyes were in the best condition for operation. I extracted both lenses with iridectomy. It was before the days of cocain; he did not squeeze his eyes or move a muscle during the operation, nor did he have one bad symptom in either eye. He remained at his daughter's home in the city for five weeks, when he returned home, fitted with glasses and able to read small type, which he continued to do until a few weeks before his death, which took place at the age of 106 years and 3 months. When I learned that one of the best operators in the land had lost both eyes of a patient from a double cataract extraction, I received such a shock that I immediately ceased to operate on both eyes at one sitting; yet, strange to say, in these 11 patients which I recall (doubtless there are more on my books) I did not have a bad result, in one of these 22 eyes, in which the vision equalled from 20/L to 20/xx in one case. When I think of this unwise proceeding I almost tremble. Surely "the wind was tempered to the shorn lamb."

For a few years I operated on one eye if ripe, but only partially so in the other; I do so no more, but refuse to operate on one eye when the patient can read with the other.

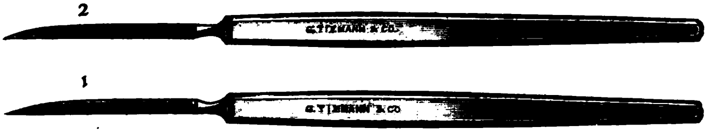
PRELIMINARY IRIDECTOMY

This I found to be the safest of all methods in the treatment of cataract. With it I have saved many eyes which would most certainly have been lost had I attempted extraction, especially is this the case when the vitreous is fluid as water. In some of these I have couched the lens subsequently. One was as follows: A frail little woman, past the forty-fifth year, suffered from trachoma in early childhood; she had been cured, but had lamellar cataract in both eyes; she was able to read for years when the back was to the light, but when I saw her the periphery of each lens was opaque. I made a small iridectomy on one eye when some fluid vitreous trickled out. In a few weeks I couched the lens, and did the same in the other eye some months later. She was able to read with either or both eyes for years, but I learned that she had to be operated on later for trichiasis by an esteemed member of this society who resided near her in a distant city. She called to see me after a few years, when I saw the lenses floating in the vitreous humor as in water. In several cases patients have consulted me who had lost one eye from an operation made by able men in distant states. A small iridectomy was made when a rush of very fluid vitreous escaped. On the fourth day the chamber was clear and revealed a shrunken lens with a narrow artificial pupil above, which enabled the individual to go about the streets and discern large letters; I did not touch the lens afterward, but "left well enough alone."

We all know that a simple iridectomy, when properly made, rarely gives any trouble, but an iridctomy combined with the extraction of the lens is a very different matter, as the iris is then the main factor in inflammations and often causes the loss of the eye. With the iris healed and no synechiæ the subsequent extraction is nearly always successful. It is my firm belief that if a preliminary iridectomy is made and followed in two months or more by the extraction of the lens our losses would not exceed 1 per cent.

EXTRACTION OF CATARACT IN THE CAPSULE

This is the most difficult and dangerous of all methods. I have done the operation on two patients, both of whom were preachers, but it was not intentional. In both of these a large corneal flap was made for a simple extraction. In one the lens presented immediately after the corneal section, fell out and rolled on the floor, the iris was replaced and the patient recovered without one untoward symptom. The second case only differed from the first in the turning of the lens on its axis and requiring a little assistance in its delivery. In this one, when I saw the unduly gaping wound, I feared a loss of the contents of the eyeball, but not a particle of vitreous presented, the iris was replaced and a beautiful round pupil remained. Both of these men had good vision for years. Here, again, there is a great difference between delivering the lens in its capsule, when from unknown causes it has become loosened from its supports, and our efforts to break up these attachments.



Knives, with convex edge (1); and with concave edge and rounded back near the point (2).

No one should attempt this most difficult operation short of placing himself under a master who has become skilful after thousands of operations. If we cannot do this, we should by all means refer patients who desire this method of operation to these experts. I flatter myself that I have had the usual percentage of success in cataract extraction, as heretofore practiced by the majority of ophthalmologists. But I could not be induced to make this operation short of a thorough training at the hands of those who have operated successfully on thousands of eyes. If the average man in the beginning attempts it he will soon discover that he not only ruins many eyes, but does himself great injury. How many of us would like to have this operation done on himself?

When I first commenced eye surgery I made the mistake of opening the speculum too widely and lost vitreous in a few cases by so doing. One cannot be too careful in selecting this instrument. It should be light, well curved, the spring not too strong, and one which can be quickly removed. I commenced with the Graefe right and left, but I have since found the one used by Dr. H. Knapp far better. For years I used the Graefe narrow, straight cataract knife, but fifteen years ago I had special knives made, some with ivory and others with metallic handles (Fig. 1). Knife 1, being convex on the edge, passes across the chamber and makes the corneal section easily and smoothly. It can be kept in order by the operator and retains its edge longer than does the very narrow straight knife, and, lastly, there is no danger of passing into the chamber the wrong way. Knife 2 has a concave edge and rounded back near its point, and I have found it very useful in preliminary iridectomies when no anterior chamber exists; one can then make the section with it just as narrow as he wishes. It is also useful in very severe glaucoma with no anterior chamber, widely dilated pupil and exceedingly narrow ring of iris. It can be worked across the chamber by passing its rounded back against the iris, thereby avoiding transfixing the iris or wounding the lens capsule as we are liable to do with the angular keratome.

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THE FILTERING CICATRIX FOR CHRONIC GLAUCOMA

WITH A REPORT OF CASES IN WHICH OPERATION WAS PERFORMED BY THE METHOD OF LAGRANGE *

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Ever since the general acceptance of von Graefe's classical operation of iridectomy as the best operative treatment in the majority of cases of glaucoma, ophthalmic surgeons have observed that, in cases of chronic glaucoma, a more permanent benefit was often obtained in those in which, through some fault in technic, a cystoid scar resulted. Such a scar usually came about as the result of some entanglement or prolapse of shreds or tags of iris, with evidences that the anterior chamber communicated with the cystoid cavities by fistulous tracts. This observation led to deliberate attempts to produce such scars, and some operators advised leaving a bit of iris tissue somewhere in the wound for this purpose. Others, like de Wecker, Priestly-Smith and Critchett, while acknowledging the possible benefits, pointed out the dangers of infection and sympathetic disturbance from this procedure. In spite of this warning, several operators have recently advocated this method of making fistulous cystoid cicatrixes, the most radical being Maher,[1] who, after making the usual incision, drags a section of the underlying iris from its attachment and leaves the loop prolapsed, to be cut off several days later, in such a manner as to leave a tag of iris in either corner of the wound. To lessen the danger in such cases, Herbert[2] advised cover-

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* This paper has been accepted by the Executive Committee of the Section on Ophthalmology of the American Medical Association, to be presented at the St. Louis Session, June 7-10, 1910. Publication rights reserved by the American Medical Association.

[1] Maher: Ophth. Rev., July, 1909.

[2] Herbert: Tr. Ophth. Soc. U. Kingdom, June, 1903.

ing the prolapse with a conjunctival flap made at the time of the incision. Holth[3] also tries to minimize the dangers by his new operation called "iridencleisis antiglaucomatosa," which he describes at length with its various incisions and modifications of iris treatment. The modification which he esteems the highest, and which he considers gives the best results, is that of subconjunctival incarceration of iris tissue combined with extrasphincteric iridectomy. He reports some excellent results and clearly establishes the possibility of creating a fistulous passage between the anterior chamber and the subconjunctival spaces with a reasonable amount of certainty. Holth's operation is far safer than Maher's and a step forward, but it remained for Lagrange to work out the possibility of obtaining filtering or fistulous scars free from iris tissue.

Ophthalmic surgeons, who have been accustomed, in operating for cataract, to make their incisions far enough back to get a good conjunctival flap, had noticed that the flap often remained edematous or even bleblike for some time after healing had taken place, and in a few cases, for years after, with the added observation that pressure on the eye would increase the edema or bleb with a decrease in tension and a partial emptying of the anterior chamber. Herbert especially called attention to this, and the explanation is found when one reads McKechnie's[4] most excellent article on the healing of variously placed cataract incisions.

Lagrange[5] reasoned that if this occasional undesirable sequel of flap extraction, with its fistulous communication between the anterior chamber and subconjunctival space, could be brought about in all cases of iridectomy for chronic glaucoma, the likelihood of future increases of tension would be greatly lessened, and the cure produced by the iridectomy made more permanent. The description of the operation which he therefore devised and called sclerecto-iridectomy, with the very excellent cuts, has been repeated so often that it is unnecessary to give a full description here.

Briefly, it consists in a sclerocorneal incision well into the angle of the anterior chamber, with the knife held, in cutting out, with the edge slightly backward so as to bevel the sclera and make a broad conjunctival flap.

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[3] Holth: Ann. d'ocul., May, 1907.

[4] McKechnie: Arch. d'ophth., May, 1909.

[5] Lagrange: Arch. d'ophth., August, 1906.

Then with the conjunctival flap pulled down over the cornea, a portion of the beveled edge of the sclera is cut off with curved scissors, the amount varying with the degree of plus tension, as experience shows that the greater the tension the less the amount necessary to remove. A good iridectomy is then made and the conjunctival flap replaced after all iris tissue has been freed from the angles of the incision. In regard to this latter point, Lagrange holds that his operation has not been properly performed if any entanglement of iris tags occurs. He reported some very encouraging results. I have performed the Lagrange operation now nine times and have not found it especially difficult or very disturbing to the eye, the amount of traumatism being less than one would expect. I find the curved modification of de Wecker's iris scissors the best to cut the beveled sclera.

Herbert,[6] in describing his wedge isolation operation, says:

> The term filtering should be restricted to smooth, even scars, which evidently allow aqueous to pass through them, but which present no dark points which we can accept as fistulous openings. The fact of filtration is shown by the edematous condition of the overlying conjunctiva, and particularly by the fact that pressure on the eye causes a marked increase of this edema, often amounting to a bleb and a marked lowering of the tension of the eye.

This operation I have never tried, as the operation of Lagrange appealed to me as being less complicated and more likely to give a permanent result. Herbert claims that his operation creates a true, filtering cicatrix, but that the operation of Lagrange creates a subconjunctival fistula. Granting that this statement be true, it still would seem to me that a tiny, subconjunctival fistula, or group of fistulas, would be more likely to remain permanent than microscopic filtering spaces in scleral scar tissue.

Thomson Henderson,[7] in an article, written from the standpoint of a pathologist, on the so-called filtering cicatrix, described the processes of healing of corneal wounds, especially those made at the limbus, pointing out the fact that "after an incision into the anterior chamber, whatever its position, or method, or formation, the endothelial cells go along with internal margin of the wound and so come to seal it off. Once the growth of endothelium is complete, the wound is no more a filtering cicatrix, but is shut off from the anterior chamber by a layer of new-formed endothelial cells, which proceed to lay down a new homogeneous membrane between the cut surfaces of Descemet's membrane." It is this endothelium that precludes, according to Henderson, all possibility of a permanent filtering cicatrix following any operative incision, however devised. He says in concluding:

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[6] Herbert: The Filtering Cicatrix in the Treatment of Glaucoma; an Improved Operation, Ophthalmoscope, June, 1907.

[7] Henderson: Ophthalmoscope, December, 1907.

> I would emphasize the fact that the success of operation in glaucoma does not lie in a "filtering" wound but in the accompanying iridectomy. The reason of the beneficial and curative action of iridectomy in glaucoma is accounted for by the fact that the cut iris surface, forming the base and pillars of the coloboma, never undergoes any reparative process, but always remains a raw, open wound, as when first severed, so acting as a permanently open filtering area through which the aqueous fluid can drain away. The efficacy of this drainage area depends on the operation being done before atrophy of the iris stroma has progressed too far.

He seems to make out a very clear case against the permanence of the filtering scar as defined by Herbert, but does not disprove the possibility of the fistulization of an iris-free cicatrix. He does not explain away the observation of the several operators who have seen cicatrices, without macroscopic evidences of fistulization, that would allow the emptying of the aqueous into the subconjunctival spaces following pressure on the globe.

Abadie[8] has also expressed a pathologist's disbelief in the filtering cicatrix, asserting that in simple section of the iris must be sought the true remedial agent. He regards it as established that "(1) Lagrange has so far failed to furnish satisfactory proof that simple chronic glaucoma can be cured by sclerectomy; and (2) glaucoma cured by sclerectomy or by iridosclerectomy might equally well have been cured by iridectomy, a simpler and less dangerous operation."

Dr. Doyne[9] reported a favorable case done before the surgeons at the Oxford Congress by Lagrange, but does not mention the ultimate success as to filtration.

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[8] Abadie: Arch. d'ophth., January, 1909.
[9] Doyne: Ophthalmoscope, June, 1908.

Dr. J. E. Weeks[10] presented four cases to the Section on Ophthalmology at New York Academy of Medicine, stating that the operation impressed him favorably.

Thompson[11] presents very clearly and concisely the gist of the controversy on the so-called filtering cicatrix. He says: "Nothing in ophthalmology could well be of greater importance than the determination whether or not an iris-free filtering cicatrix can be made in the corneo-scleral margin, when operating for chronic glaucoma." He then goes on to describe the claims of Herbert and Lagrange, who, by their operations, are trying to establish a permanent path for the passage of aqueous from the anterior chamber into the subconjunctival tissue. He then gives Henderson's views as to the impossibility of making a permanent, iris-free, filtering scar, such as Herbert claims to obtain.

Lagrange[12] steps into the arena again, with a very able defense of his operation. In regard to the cystoid cicatrix, he makes the following very timely remarks: "A cystoid cicatrix, obtained at the price of an entanglement of the iris, is unwelcome and dangerous, and one should aim at creating a cicatrix fully as filtering as the cystoid one, without the uveal tract participating in its formation." He insists on going with the section through the ligamentum pectinatum iridis and dividing the insertion of the ciliary muscle, so as to establish a communication between the lymph spaces of the chorioid and the anterior chamber. He shows that von Graefe and de Wecker both understood the usefulness of the filtering cicatrix, but he gives to de Wecker the credit of having brought into prominence the value of this cicatrix. He also shows that de Wecker was opposed to the entanglement of iris in the efforts to obtain such a cicatrix. He goes on to describe the utility of the filtering cicatrix, and shows that "when it occasionally follows a simple iridectomy it is the result of the hypertension of the eye, and does not occur in chronic glaucoma without this hypertension." In such cases of glaucoma he states that iridectomy has no value, or but a passing one, because the lips of the wound fall into apposition, either immediately after the incision or more or less quickly after the section has been made.

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[10] Weeks: Arch. d'ophth., May, 1908.
[11] Thompson: Ophthalmoscope, February, 1908.
[12] Lagrange: Arch. d'ophth., February, 1908.

"Dieresis must be replaced by exeresis, since by the former it is impossible to produce a definite filtering cicatrix, which, on the contrary, one can get readily by exeresis of the sclerotic." He says:

> My operation of sclerecto-iridectomy has the primary advantage of opening up a communication between the choroidal space, on the one hand, and the aqueous chamber on the other. It satisfied, therefore, the wants of those who believe that chronic glaucoma largely depends on the obliteration of that space. In the second place, it does away with the obstruction of the angle of the anterior chamber, when such exists, and lastly, it establishes a communication between the aqueous chambers and the perichoroidal space and the meshes beneath the conjunctiva.

He describes three varieties of the filtering cicatrix based on the amount of sclera removed and the result of such removal. In the first variety there is the simple thinning of sclera; the second is the so-called subconjunctival fistula; and the third variety, in which there is ampulliform elevation of the conjunctiva added to the fistulization, resembles a cystoid cicatrix, but without the entanglement of iris. Lagrange states that since he began to operate on patients with a view of obtaining this form of the cicatrix he never has seen the least damage result from the operation.

Lagrange,[13] in a communication made to the Paris Ophthalmological Society, reports cases of simple sclerectomy giving successful results, which he considers more convincing proof of the value of the filtering cicatrix than cases of the combined operation, and especially is this true of the cases, like Valude's,[14] yielding good results where a previous simple iridectomy had failed. In concluding, Lagrange advises simple sclerectomy for cases having a tension of + 1 or less, reserving the combined operation for those having a greater tension. Later, Lagrange[15] answers M. Abadie's four objections to the operation of sclerecto-iridectomy, giving the clinical proofs in support of his claims.

Weekers and Heuvelmans[16] demonstrated, by experimentation on the eyes of rabbits, that it was possible to obtain a filtering cicatrix. They concluded from their experiments that it was ne[illegible]sary to excise a portion of the whole thickness of the sclera, and as near the cornea as possible, in order to obtain a fistulous opening. They also state that it is necessary to do an iridectomy in most cases to prevent the inclusion of iris tissue in the opening.

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[13] Lagrange: Arch. d'ophth., August, 1908.
[14] Valude: Ann. d'ocul., May, 1908.
[15] Lagrange: Arch. d'ophth., November, 1908.
[16] Weekers and Heuvelmans: Arch. d'ophth., November, 1909.

Rochon Duvigneaud,[17] in discussing the Lagrange operation, and describing two cases, insists that the third variety of the Lagrange filtering cicatrix must be obtained if permanent reduction of tension is aimed at, that the simple thinning of the sclera obtained in the first variety is in no sense a filtering area, and that the improvement obtained in cases of chronic glaucoma, having such cicatrices, is due solely to the accompanying iridectomy. Apropos of the first variety of the Langrange cicatrix, Bettremieux[18] has endeavored to lessen the resistance of the sclera by grooving it near the cornea, without opening the anterior chamber.

Holth[19] describes a modification of the Lagrange operation, in which a modified Dr. Vacher punch forceps is used to remove the bit of scleral tissue. He tried taking the rounded piece of scleral tissue from the posterior lip of the wound, but finally decided to follow the method of Lagrange and take it from the anterior lip, using the punch forceps instead of the scissors.

Holth considers that the following three conditions must be fulfilled before an operation for the cure of glaucoma by the production of a fistulous cicatrix can be considered to have answered the purpose for which it was devised. He postpones publication of his results until sufficient time has elapsed to allow of their being fulfilled in a series of cases:

1. There must be conjunctival edema over and around the scleral wound, showing the presence of a subconjunctival fistula.
2. The tension must be constantly normal or subnormal, as shown by the tonometer.
3. For two years after the operation, the visual acuity and fields (which often improve to a marked extent) must not become worse than they were before.

Finally, Holth expresses his opinion that, although the classical iridectomy is still indicated in acute glaucoma, yet Lagrange's idea was a most happy one, and that anterior subconjunctival sclerectomy is destined to be the basis of all the future surgical treatment of chronic glaucoma.

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[17] Duvigneaud, Rochon: Arch. d'ophth., March, 1908.
[18] Bettremieux: Clin. Ophth., August and September, 1907.
[19] Holth: Ann. d'ocul., July, 1909.

Major Elliott[20] concedes that Herbert and Lagrange have proved their case, but considers that "the operation of Herbert is a difficult and complicated procedure, and that the operation of Lagrange, while less difficult, offers some risks," while the operation he advocates can be easily performed, and without the same risk. Briefly, his operation consists in trephining at the limbus with a 2-mm. trephine, leaving the button in place, or removing it with the trephine or scissors and forceps. In most of his cases the button was removed, and in some, twenty-one out of fifty, a small button of iris was removed. Fifty patients were operated on, and in no case up to the time of publication had the operation failed to relieve tension.

In another article[20] Major Elliott reports four cases showing the evidences of a filtering cicatrix a long time after operation; the first, eighty-six days; the second, three and one-half years; the third, seven and one-half years; and the fourth, ten years. The last two of these appeared to owe their filtration to tiny fistulization. His communication, he states, is simply a preliminary note on a new operative procedure for the establishment of a filtering cicatrix in the treatment of glaucoma. At the December meeting of the New England Ophthalmological Society, Dr. Verhoeff[21] presented a circular punch based on the principle of the bicycle tire punch, which will remove a button of sclera at one or both ends of a sclerocorneal incision, with a minimum of traumatism. He first cuts a conjunctival flap, which is pulled down over the cornea, and a sclerocorneal incision is then made with a keratome. The little rounded guard of the punch is then slipped into the wound, and to one corner, when by screwing down the sharp-edged cylinder, the button is cut and removed with the instrument. A small extrasphincteric iridectomy is then made. Fergus[22] also recommends a similar modification of Lagrange's operation by using the trephine, which is applied far enough back to avoid opening the anterior chamber, to which he adds a modified cyclodialysis obtained by pushing a repositor between the exposed ciliary body and the sclera, until its point comes into the anterior chamber. He has, therefore, modified the operation of Heine rather than that of Lagrange. Stephenson[23] reviews the use of the trephine in the treatment of glaucoma, calling attention to its advocacy by Argyll Robertson thirty-four years ago, and later by Blanco and Frölich. These operators removed the scleral piece posterior to the ciliary body, while Fergus, Elliott and Verhoeff, now remove the disc from a point nearer to the limbus.

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[20] Elliott: Ophthalmoscope, December, 1909.
[21] Verhoeff: Ophthalmoscope, March, 1910.
[22] Fergus: Ophthalmoscope, February, 1910.

In 1905, Heine brought out his operation of cyclodialysis for the establishment of a passage for the escape of aqueous from the anterior chamber into the suprachorioidal space, and in the discussion of the question of a filtering cicatrix it would seem proper to bring up the question of this operation, which, however, could hardly be compared with the true filtering cicatrix, in that the passage of aqueous into the suprachorioidal space, following cyclodialysis, has been proved to be only temporary. The operation, however, is of value in certain classes of cases where a sudden emptying, or partial emptying, of the anterior chamber is unwise. In such cases, Heine's operation should not constitute the whole treatment, but should be employed preliminary to a Lagrange, or some of its modifications. It is especially indicated in cases in which there is a high degree of tension with a marked sclerosis of the retinal arteries and consequent danger of hemorrhage, and particularly in those cases in which the fellow eye has been lost by reason of such an accident. Weekers[24] reports on five cases, in which Axenfeld operated after Heine's method, and which gave disappointing results in that the tension fell only to rise again. The operation devised by Fergus may prove to be a modification of the Heine, with the advantage of more permanent results. Fuchs has tried trephining, but operating away from the cornea, and only found that temporary relief was obtained. He has also tried Heine's operation, but has given it up as it did not permanently cure the condition, and as on pathologic examination it was shown that in cases in which cyclodialysis had been performed cicatrization completely occluded the spaces between the anterior chamber and the perichorioidal space. Arnold Knapp[25] reports a number of favorable results following the use of Heine's operation in his hands, but the general opinion of surgeons who have tried the operation seems to be that it is not permanent enough in its effects to generally replace iridectomy for chronic glaucoma while the Lagrange operation, or some of its modifications, seems to be growing in favor.

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[23] Stephenson: Ophthalmoscope, February, 1910.

[24] Weekers: Klin. Monatsbl. f. Augenh., August-September, 1907.

[25] Knapp, Arnold: The Operative Treatment of Glaucoma by Cyclodialysis, THE JOURNAL A. M. A., Sept. 4, 1909, liii, 765.

CASE 1.—*History.*—The patient, F. M., aged 23, watchmaker, came to me Sept. 13, 1907. The case is especially interesting on account of the youth of the patient. The family history is also interesting in that the mother, at the age of 46, came to me with absolute glaucoma of the right eye, which, not yielding to iridectomy twice performed, required removal. Outside of glaucoma in the mother, there is no other family history of importance in the case. For three months before the patient came to me, the sight of the right eye had gradually failed with occasional attacks of discomfort, and the constant appearance of a rainbow around lights. On waking up in the morning both eyes were slightly congested, but this passed off in a very few hours.

Examination.—This showed the right eye vision equal to perception of light and perception of movements in the temporal field only. Tension + 1, and the pupil slightly dilated with anterior chamber shallow. The fundus showed a cupping of the disc amounting to three diopters with the retinal arteries pulsating. The left eye showed a vision of 20/30, field of vision normal, pupil slightly dilated and anterior chamber slightly shallowed, tension possibly slightly above normal, but difficult to determine owing to inability to compare with the normal eye. The fundus showed a cupping of about two diopters. Arterial pulsation only on pressure. In both eyes the optic discs were unusually large with the cupping sharply at the edge of the disc and sclera, with the vessels disappearing momentarily, entirely, in both eyes. The right eye showed entire loss of the nasal field up to the middle line.

Pilocarpin was immediately ordered and arrangements made for the patient's admission to a hospital for operation. The pilocarpin reduced the tension in the right eye, and contracted the pupils well, improving the vision in the right eye to counting fingers at two feet, in the temporal field, and improving the left eye to a vision of 20/30.

Operation.—On September 18 a Lagrange operation was performed on the right eye, and as this was the more advanced as to the glaucoma, only a small portion of the beveled edge of the sclera was removed. A moderate-sized iridectomy was performed and the large, well-shaped conjunctival flap was easily replaced. I was surprised at the ease with which the conjunctival flap could be pulled down over the cornea, out of the way, allowing an iridectomy to be performed as easily as after a keratome incision. A week later the same operation was performed on the left eye, and a large-sized piece of sclera removed. In this eye I also obtained a very good iridectomy and reposition of the conjunctival flap.

Postoperative History.—The healing was uneventful and unaccompanied by any entanglement of the iris in the wound. The edematous condition of the conjunctival flap was, of course, very marked, especially in the left eye. This condition of localized edema, which could be increased on manipulation of the eye, persisted for several months, and was present when the patient was seen Jan. 20, 1908, at which time the left eye showed a vision of 20/20, with a —2 cyl., axis 90°. The right eye could count fingers at two feet, in the temporal field, and in both eyes the tension was normal or even subnormal. The patient had returned to his work at the watchmaker's bench. I saw him again March 1, 1910, more than two years after my last record, and found the following conditions: The right eye, which looked perfectly white and quiet, still retained the same amount of vision, and had a normal tension. The line of incision showed very plainly as a bluish mark from 0.5 to 1 mm. in width, extending a little less than the length of the original incision. Just to the left of the center of this bluish line, there was a round bluish opening with a refracting center, as though a bubble of air were caught just under the conjunctiva. It had a diameter of 1 mm. and I felt that this represented a distinct fistulous opening into the anterior chamber. There was no surface elevation of tissue over this spot, but the conjunctival tissue represented by the original flap was slightly and evenly edematous, with a slight increase of this condition following pressure on the lower part of the eye. Continued pressure, however, did not create anything like a bleb or visibly decrease the fluid in the anterior chamber. The left eye showed, with his glass, a vision of 20/15. The eye was perfectly white and quiet with normal tension and no sign of conjunctival edema, and the incision showing as a bluish line, rather wider than that in the right eye, but having no appearance of fistulization.

In this case it is evident that the glaucomatous condition has been entirely relieved, though it is questionable if there is any filtration, at present, through the cicatrix of the left eye. It seems justifiable to suppose, however, that the marked filtration which was present for more than three months after operation allowed a more permanent cure from the iridectomy. The right eye, however, shows, after over two years, most of the evidences required to prove the presence of an iris-free filtering or fistulous cicatrix. My previous experiences with miotics and simple iridectomies for such advanced cases as represented by this right eye would lead me to expect a steady decline in vision instead of the complete maintenance of a vision which this patient insists is of great help to him.

CASE 2.—*History.*—The patient, Mrs. G. H., gave a negative family history. For several years the sight in her right eye had been gradually failing up to Dec. 15, 1907, when she was stricken with a very severe attack of capillary bronchitis, and on the following day developed an acute attack of glaucoma in this right eye.

Examination.—When I saw the patient, December 16, I found the right eye in condition of acute glaucoma, with entire loss of vision, steamy cornea, with greenish pupillary reflex; tension + 3, and eye very much inflamed with conjunctival chemosis and extreme pain. She was coughing incessantly, and in view of her condition it was considered inadvisable to operate. Eserin was accordingly prescribed to be used every three hours, and under this the pain ceased, the pupil contracted to nearly normal size, the cornea became less steamy, and the patient could discern movement of the fingers at two or three feet.

Operation.—No further improvement in vision took place, however, and the patient's condition improving, a Lagrange operation was performed on both eyes Jan. 2, 1908. The performance of the operation was very difficult on the right eye owing to the shallowness of the anterior chamber and excessive hemorrhage. The operation on the left eye was performd with no difficulty, and semed advisable on account of the finding of slight cupping of the disc and shallowness of the anterior chamber, with a slightly larger pupil than one would expect in a woman of her age. There was, however, no increase of tension, but the eye was evidently in a condition to develop glaucoma easily. The healing was uneventful in both eyes, with appearance similar to those described in the first case. The right eye, however, at the end of three weeks developed some increased tension and pain, and there were no signs of escape of aqueous into the subconjunctival space. A second Lagrange operation was then performed to the temporal side of the original one.

Postoperative Condition.—This resulted in reduction of tension, which has remained up to the present time, though the eye has only perception of light, practically no increase of vision having been obtained from either operation. This patient was seen again March 1, 1910, over two years after the performance of the operations. The left eye showed perfectly quiet and white with no conjunctival edema, and good clean coloboma without entanglement of the iris in the wound, and the line of incision showing as a bluish-gray area, about 0.5 mm. wide, extending nearly the full length of the original incision. There was no sign, however, of fistulization, to the naked eye. The vision with a + 3.50 sph. combined with a + 1.12 cyl., axis 175°, is 20/20. ~~The right eye~~ showed a regular, continuous, bluish line along the site of both incisions, varying from a millimeter in width down to nothing. At the point where the two incisions came together, and also at the nasal end of the first incision, there was some entanglement of iris. There was no sign of conjunctival edema, but there was a small, bluish cystoid scar at the nasal side containing some iris tissue without other signs of a fistula. The tension was normal, and there was absolutely no pain or discomfort.

The other Lagrange operations which I have performed are so recent that I will not detail them, but simply state that all four, up to the present, show the conjunctival bleb indicative of aqueous escape into the subconjunctival spaces. They were all performed in cases of simple glaucoma in which no history or signs of previous acute or subacute attacks had ever been present, and in which the vision and fields were much reduced, and the discs cupped and atrophic; the results so far have been most encouraging as to improvement in a vision which had been steadily failing under the careful use of miotics. I should state here that in neither of my two reported cases, which now are over two years old, has any miotic been used since the Lagrange operation, nor has any been used since operation in the newer cases, so that all the improvement and maintenance of vision must be ascribed to the operation.

From my reading coupled with my personal observation, I feel reasonably sure that the Lagrange operation, or one of its modifications, has come to stay because it is a distinct advance in our operative treatment of chronic glaucoma, in that it makes the effect of an iridectomy more marked at first, and more permanent later, thus keeping the vision existing at the time of operation much longer than can be hoped for from miotics, simple iridectomy, sclerotomy or cyclodialysis.

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MEMORANDA

PLASTIC SURGERY OF THE EYELIDS, USING THE WOLFFE GRAFT *

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Plastic surgery has always impressed me as being the height of all surgical skill. For obvious reasons plastic surgery about the face, about the eyelids particularly, not only requires good judgment on the part of the operator, but his technic is put to the severest test.

The operation for the restoration of the lids and of the cul-de-sacs in contracted orbits, in the complete ectropions, especially from burns, and many other conditions, makes the deep cutaneous graft of Wolffe the ideal one to be used in such cases. My experience in twenty-five cases in which this cutaneous graft was applied has been so satisfactory and the method employed is so simple that I present the subject with the hope that it will be of interest. No claim is made to originality in the operation to be described, for my ideas were obtained from observing other operators.

There are two important steps to be remembered: First, the surface to be grafted must be denuded and must have sufficient blood-supply to nourish a healthy graft; second, a graft must be obtained of sufficient size to more than cover the area.

The ideal case is a complete ectropion of the upper or lower lid, and the one I now report, in which the result was most brilliant, was that of a farmer who, eighteen years before the first operation, fell into an open fire, burning the left side of his face and forehead. In time there was a complete distortion of that side of the face from the cicatricial contraction, and the ciliary margin of his upper eyelid occupied the position of his eyebrow, which had been destroyed, and the margin of the lower

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eyelid was pulled well down on the cheek. The conjunctival surfaces of the lids were completely everted and exposed, and from prolonged exposure they had become much thickened, resembling a velvety type of trachoma. The picture he presented was horrible. Fortunately the man had excellent vision, the globe in no way being injured. Two operations, at six months' interval, were required, the upper eyelid being first operated on.

After cleansing the face with ivory soap and water, then irrigating with a normal saline solution, I made a superficial incision above the ciliary margin, then little by little I undermined the whole lid, as one would in an ordinary integument dissection, preserving the muscular structure. This flap of the lid, when folded down over the globe, nearly covers the entire exposed conjunctival surface of the lower lid. Bleeding is of no consequence, but should this be troublesome a small artery clamp applied for a few moments would control the annoying vessel. After this part of the operation is completed, and the operator is sure that the eyelid will remain in place from its own weight, a pad saturated with hot saline solution is applied and gentle pressure made by an assistant, while the graft is obtained from the inner surface of the arm, forearm or thigh. I have never obtained a graft except from the inner arm, and in one case I removed, at intervals, five grafts from the two arms. The left arm is generally prepared, after the usual manner of shaving, cleansing with green soap, bichlorid of mercury and a saline dressing applied some hours before the operation, so that the graft will be as little irritated as possible at the time of the operation. A nurse or an attendant holds the arm out from the body by the hand, and the arm is wrapped with sterile towels.

Some idea should be had as to the size of the place to be covered, and I usually measure it roughly with the handle of my scalpel, then make the graft at least one-third larger, allowing for shrinkage and a loose fit. An oval graft is advisable, as the wound of the arm which is to be subsequently closed leaves only a linear scar. I usually mark off on the skin of the arm with the knife four small lines indicating the size of the graft, then connect them with a superficial incision, and as the graft is removed the incision is deepened, extending down to the fatty layer. A pair of tissue forceps and a Desmarres lid scarifier are the only instruments necessary in this step of the operation.

The graft should not contain any of the areolar or fatty tissue, and on its removal, with a pair of scissors curved on the flat, the raw surface should be trimmed of all the loose and unnecessary tissue; it is then placed in a towel wet with warm saline solution and is ready to be applied to the raw surface previously made.

The arm wound can be repaired by an assistant, or later by the operator. This operation simply consists in undermining the edges sufficiently to bring them together without tension. Two or three silkworm gut retention sutures are best used, followed by a continuous silk suture of coaptation; a dry dressing is applied and the wound is not disturbed until the fourth day. The nurse should watch for swelling of the hand for several hours after the operation; if present, this would indicate a restricted blood-supply from too tight a bandage or tension of the wound.

The new graft should be applied immediately to the raw surface for its nourishment, but all bleeding of the wound must first be controlled, lest a blood clot subsequently forming beneath the graft delay healing or form a good nidus for infection. I use a strabismus hook to smooth the graft into place, and it is remarkable how an irregular surface can be beautifully and evenly covered. Small sutures of No. 5 black silk are used to hold the graft in place. They are first placed at four equidistant points, to even the graft, then the space between is filled in with as few as possible to hold the graft steady. If the graft is too large, it can be trimmed after it is in place; but it is better to have a too large, loose fitting graft than a too small, tight one. The subsequent contraction may spoil a beautiful operation.

A dry dressing is applied, made up of several layers of gauze to absorb the secretion, then loose gauze on top. The first dressing should not be made sooner than the fourth day, then the adherent pieces of layer gauze should be moistened in order not to pull apart the wound. The sutures can be removed, or at least a part of them, for I have found that delayed removal may cause a slight infection, which may destroy the graft. Sterile vaseline should be gently smeared on the wound, and a tight dry gauze dressing applied. At intervals of two or three days the dressings should be changed until the superficial epithelium of the graft commences to slough, then the wound should be cleansed daily. The slough may be frequently trimmed. In about three weeks the patient can go without a bandage or other protection, but for many months later it is well to have the patient massage the new lid daily with vaseline, so that it may be kept soft.

In my second case of ectropion of the lower lid there was a slight recurrence two months afterward, but daily massage entirely corrected the condition. The method of restoration of the cul-de-sac by using the Wolffe graft is described in the excellent monograph of Weeks.[1] While the major points of that operation are similar to the method just described, some niceties in technic and the application of sutures and the use of the dental rubber plate for the holding of the graft are more thoroughly explained.

While the operation that I have just described applies best to flat surfaces to be grafted, chiefly ectropions, I have recently used it with success in two nose cases in which the alæ had been destroyed by burns, and in a case of burn in which the upper lip had been pulled high up on the cheek from the scar contraction. The vermillion border was undermined, the scar in part being dissected out and a very loose graft applied. The appearance was much improved.

So far I have not had an infection or a complete failure. The nearest approach to failure occurred in a severe case of ectropion of the lower lid referred to me by Dr. W. P. Nicolson. The patient had had a mole removed from his cheek years ago by the application of some caustic paste, which had caused so much tissue necrosis that most of the soft tissue of the cheek on one side had been destroyed, exposing parts of the upper and lower jaws. Dr. Nicolson restored the cheek by a pedunculated graft removed from the neck, and referred the patient to me to correct the lid deformity. There was little sound surface for the graft, except the deflected ectropic lid, and the slough that followed only delayed epidermization.

672 Peachtree Street.

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[1] Tenth Congress of Ophthalmology, Lucerne, 1904.

MEMORANDA

MEMORANDA

THE NOGUCHI SERUM REACTION FOR SYPHILIS AS AN AID TO DIAGNOIS IN EYE LESIONS*

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The serum diagnosis of syphilis as given to the world by Wassermann, Neisser and Brück[1] in 1906, has now become a well-established diagnostic method, generally used in all medical centers, and has proved of value in all fields of medicine.

The Wassermann method is an adaptation of the Bordet-Gengou phenomenon of complement deviation, in which the hemolytic system consists of a suspension of washed red blood cells of the sheep, hemolytic amboceptor made by immunizing rabbits to sheep's red blood cells, and as complement fresh guinea-pig serum. For syphilitic antibody the serum from suspected patients is used, and for antigen a watery extract of a liver of congenital syphilis known to be rich in *Spirochæta pallida.*

It has been pointed out that there is one factor of error in this method due to the fact that there is in human serum a variable amount of natural antisheep amboceptor which tends to produce hemolysis and hence a negative reaction in the presence of the smaller amounts of syphilitic antibody To avoid this error Noguchi[2] has proposed a change in the hemolytic system. His modification consists in using human red blood cells, with antihuman serum from rabbits, instead of sheep's cells and hemolytic serum from rabbits as used by Wassermann. By the use of this antihuman hemolytic system the variable antisheep amboceptor of human serum is eliminated as a disturbing factor. Noguchi has also found it possible to prepare antigen, antihuman hemolytic amboceptor and guinea-pig complement, in the form of reagent papers which remain fairly stable so long as kept perfectly dry, thus simplifying the method without any sacrifice in accuracy. His views regarding the use of complement dried in paper have been modified within the past few months and now he considers it advisable to use the liquid complement whenever possible, the use of complement in paper to be reserved for emergencies.

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[1] Wassermann, Neisser and Brück: Deutsch. med. Wchnschr., 1906, xxxii, 745.

[2] Noguchi: A New and Simple Method for the Serum Diagnosis of Syphilis, Jour. Exper. Med., 1909, xi, 392.

The technic of the test is described in detail in Noguchi's work[3] and is quoted in brief as follows:

> Only about 2 c.c. of the patient's blood is needed and this may be obtained by puncturing the index-finger or lobe of the ear and collecting the blood in a small glass tube. The blood-clots and the serum separate in a few hours at room temperature. If the test is not to be made within two or three days the serum should be drawn off with a capillary pipette for storage.
>
> The corpuscle suspension can be prepared with the blood of a normal person. The blood is allowed to drop into a test-tube of salt solution. The proportion should be one drop for each 4 c.c. The quantity of the suspension thus prepared is enough for one complete test, with some left over in case it is necessary to repeat the test. The suspension must be allowed to stand over night in a cool place, or is centrifugalized soon after collection, to separate the cells. The supernatant fluid is carefully poured off and replaced with a fresh salt solution and a suspension made by shaking. This operation removes the serum constituents, and especially the fibrin ferment, which often disturb the test. A 1 per cent. suspension of the washed corpuscles should be used.
>
> To facilitate the carrying out of the test a rack containing two rows of holes for the tubes should be used. For each test two tubes are required, one in the front row and its control in the rear row. There will also be two pairs of tubes to serve as positive and negative controls.
>
> Put into each of two small test-tubes, front and rear, one drop (about 0.02 c.c.) of the serum to be tested from a capillary pipette. Add to each tube 0.1 c.c. of 40 per cent. fresh guinea-pig serum made by adding 1 part of complement to 1½ parts of 0.9 per cent. salt solution. In an emergency or where fresh complement cannot be obtained dried slips of paper, each containing two units of complement, may be substituted. To

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[3] Noguchi: Serum Diagnosis of Syphilis, J. B. Lippincott, 1910.

the front tube add the slip bearing the antigen. Then to both tubes add 1 c.c. of the 1 per cent. suspension of washed human corpuscles. Shake the tubes thoroughly from time to time to distribute the reagents evenly throughout the mixture as they dissolve out of the paper.

With every series of tests it is necessary to carry out two sets of controls, and for this purpose four additional tubes will be necessary. To each of the first pair of these, one in the front and one in the rear row, is added one capillary drop of a syphilitic serum known to give a positive reaction. This will serve as a positive control. To the second pair add one drop of normal serum known to give a negative reaction; or the tubes may be left empty. This pair of tubes will serve as a negative control. Now put into each tube complement and into the tubes of the front row only antigen, adding finally 1 c.c. of the corpuscle suspension to each tube.

Place the rack holding these pairs of tubes in a water-bath, thermostat, or warm place not over 37 C. The vest-pocket is warm enough and convenient in an emergency when none of the above is at hand. Allow an hour from the time the mixture is made for the antibody to combine with the antigen and for complement to be fixed. If a water-bath is used, thirty minutes is a sufficient length of time. If dried paper complement is used this period of incubation should be extended to twice as long as is the case when liquid complement is used. The contents of the tube are as follows:

Rear: Test serum + complm. (2 units) + 0 + corpuscle susp. 1 c.c.

Front: Test serum + complm. (2 units) + antigen + corpuscle susp. 1 c.c.

First incubation at 37 C. for one hour; then add to each tube, both front and rear, a slip bearing two units of amboceptor. Allow another two hours in the thermostat or one hour in water-bath. After final incubation the tubes should be kept at room temperature for a few hours before the results are recorded.

It is necessary to make certain that the tests in the control sets have been properly carried out. The pair of tubes containing normal serum (or without any serum) must be completely hemolyzed. These constitute the negative controls and show that the hemolytic system used is effective, and that the amount of antigen used is not by itself inhibitory of hemolysis. Next, the front tube of the positive control set, containing a known syphilitic serum, must show total inhibition of hemolysis, while the rear tube must show complete hemolysis. Thus we are certain by the rear tube that the syphilitic serum itself does not inhibit hemolysis, while the front tube, in which hemolysis is inhibited, shows the ability of syphilitic antibody to fix complement in the presence of the antigen employed.

These essentials having been fulfilled, the tubes containing serum for diagnosis can be scrutinized. In these tests hemolysis must be complete in the rear row, since antigen is not present and the amount of serum used should not be inhibitory. Should hemolysis be inhibited markedly, showing usually an anticomplementary action on the part of the patient's serum, this may be overcome by "inactivation" of the serum for thirty minutes at 56 C. (before commencing), after which it will be necessary to use four to five drops of the serum in the test. The time of inactivation for this purpose may be shortened to fifteen minutes (instead of thirty minutes) and three dops of the serum used in this instance. The anticomplementary action can be overcome also by the use of a larger dose of complement. In case inhibition is only slight in amount, the addition of 0.15 to 0.20 c.c. of a 40 per cent. complement mixture (mentioned already) can be used. The above irregularities are occasionally encountered in the test, especially during the summer months.

The tubes containing the serum for diagnosis and antigen, the front row of tubes, may be examined for final results. Here any degree of hemolysis may be encountered, from total inhibition to complete dissolution of corpuscles, depending on the presence or absence of syphilitic antibodies and the number of antibody units. With complete inhibition of hemolysis, the end reaction is easily interpreted, the corpuscles settling to the bottom of the tube with the clear salt solution above. Complete hemolysis likewise gives a result easy of interpretation, for the corpuscle mass is entirely dissolved, the hemoglobin going into solution and coloring the salt solution a deep reddish color.

By taking into consideration the bulk of corpuscles settling to the bottom of the tube and the amount of tinting of the supernatant salt solution, and by comparison with the positive and negative controls, the varying degrees of inhibition of hemolysis may be ascertained. In interpreting the result complete inhibition of hemolysis comparable with the positive control is called strongly positive; complete hemolysis, comparable with the negative control, is designated as a negative reaction. If 60 to 70 per cent. of the bulk of corpuscles is dissolved the reaction is doubtful and should not be taken into consideration for diagnosis. In a known specific case such slight inhibition should be an indication for further treatment as evidence of the continued presence of syphilitic antibodies in the patient's blood. If there is a faint degree of hemolysis, the main bulk of corpuscles being intact, the reaction should be called positive. A more intense hemolysis, with about 10 to 20 per cent. dissolution of the corpuscle mass, should be called weakly positive, while 30 to 40 per cent. hemolysis is designated as faintly positive. Neither the weakly positive nor the faintly positive reaction should be accepted as a definite diagnosis of syphilis without the presence of strong clinical evidence in

favor of such a diagnosis. In case the reaction should be doubtful, the serum should be reexamined after a period of a week has elapsed, and if necessary several examinations in succession should be made. In all cases it is a wise precaution to take the blood for examination shortly before meal-time.

It may be stated here that all human serums gradually become anticomplementary after several days on standing, some more pronouncedly so than others. This change sets in much more rapidly at a higher temperature, such as that of a room, than at a lower temperature, such as that of a refrigerator.

In order to have a positive control test, whenever examining an unknown serum one must always have at hand a syphilitic serum known to give a positive reaction. For this purpose one has to obtain a good specimen, which can be preserved on ice for months. Should such a specimen become too anticomplementary on standing, one can remove this property by heating the serum at 55—56 C. for about fifteen minutes.

The method of titrating the antibody content of syphilitic serum in order to determine the exact strength of each specimen is fully described by Noguchi, as also the manner of preparing slips. Guinea-pig serum is used as complement and this should be used fresh, as after the serum is forty-eight to seventy-two hours old its activity is rapidly lost, even at refrigerator temperature if the serum is kept in a fluid form.

Antihuman hemolytic amboceptor is made by immunizing rabbits against human blood corpuscles. Large rabbits are injected with increasing amounts of washed human blood corpuscles five times in succession intraperitoneally, allowing a four-day or five-day interval between injections. Nine or ten days after the last injection the rabbit may be bled from the carotid artery, the blood collected in a tube and placed at room temperature for several hours before being transferred to the refrigerator. At the end of twenty-four hours the clear serum is collected by decantation and this should be titrated to determine its strength. Different rabbits react differently to amboceptor production and often a weak serum will be obtained after a long immunization, while at other times a powerful serum may be obtained after four injections. A good preparation will have a value of one unit in something less than 0.001 c.c. of serum; that is 0.001 c.c of serum or less will cause complete hemolysis of 1 c.c. of a 1 per cent. suspension of human erythrocytes when combined with an excess of complement, say 0.02 c.c. of fresh guinea-pig's serum.

Noguchi states that alcoholic extracts of certain tissues contain variable quantities of antigen for syphilis. There is more in heart, liver or kidney than in nervous tissues, so far as has been determined. The liver of a congenitally syphilitic fetus is one of the tissues richest in these antigenic lipoids. In the preparation of antigen the procedure is as follows:

> Extract a mashed paste of liver, heart or kidney of man, ox, guinea-pig, rabbit or dog with ten parts of absolute alcohol at 37 C. for several days. Filter through paper and collect the filtrate. Bring the latter to dryness by evaporation, and take up the residue with a small quantity of ether and add five volumes of acetone. A precipitate forms, which is allowed to settle to the bottom of the vessel and the supernatant fluid decanted off. This insoluble residue contains antigenic lipoids and its strength is estimated by taking 0.2 gram of the residue, dissolving it in about 5 c.c. of ether, and gradually adding 100 c.c. of physiologic salt solution to make an emulsion. If flocculent it may be filtered through paper to remove the precipitate. This opalescent emulsion is used for the fixation test to find out the quantity needed to cause complete inhibition of hemolysis when combined with a good syphilitic serum. Inhibition is caused by the coexistence or simultaneous presence of antigen and syphilis-antibody, and is of diagnostic value. Any quantity of the emulsion which is capable of causing complete fixation may be used for the test, but it is best to choose the maximum dose which is without inherent anticomplementary action.

Noguchi says that his method if properly carried out gives uniform and reliable results; but as the activity of the complement and the resistance of the red corpuscles sometimes vary according to their source and age, certain irregularities sometimes arise, which necessitate a knowledge of how to adjust relatively the quantities of these factors. There are no difficulties that arise which cannot be removed by the proper use of the several reagents, and definite and detailed information concerning the manner of eliminating error is given. Whether the active, old or inactivated serum is used is only a matter of personal choice, provided that the rules prescribed for active and inactive serums are observed.

Concerning the value of the serum test for the diagnosis of syphilitic conditions, Williams[4] states that by combining the figures obtained from numerous investigators comprising over 8,000 tests, an average of 75 per cent. positive reactions were obtained in all cases of hereditary and acquired syphilis. He has tabulated the results, which are given in Table 1.

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[4] Williams: The Serum Diagnosis of Syphilis, Colorado Med., April, 1910.

TABLE 1.—POSITIVE REACTIONS IN 8,000 CASES OF HEREDITARY AND ACQUIRED SYPHILIS (WILLIAMS)

Stage of Disease.	% Positive.
Primary syphilis	70
Secondary syphilis	89
Tertiary syphilis	78
Early latent (late secondary symptoms)	51
Late latent (following tertiary symptoms)	47
Hereditary syphilis	95
Cerebrospinal syphilis	48
General paralysis	88
Tabes	63

Taking into consideration the fact that this includes tests made by various methods, some of which have been proved to be open to considerable error, it would seem that the value of the serum reaction has been thoroughly demonstrated.

Noguchi's method seems to be a distinct improvement over that of Wassermann or any of the other methods proposed for the reason that it is not so complicated and cumbersome; and the statistics seem to show that it is more accurate and more delicate. Thus, in a comparison of the Wassermann and Noguchi systems in 244 cases of syphilis and parasyphilitic conditions, as reported by Noguchi[3], the Wassermann system gave 183 and the Noguchi 211 positive reactions. Noguchi further states that in a series of 1,082 cases examined, in which there were a number of syphilis suspects, 802 positive reactions with the Noguchi test were obtained.

In a comparison of the Wassermann and Noguchi systems Fox[6] reports 210 cases examined with the percentages of positive reactions favorable to the Noguchi test. This series of cases included primary, secondary, tertiary, latent and hereditary syphilis, tabes, cases for diagnosis and non-syphilitic cases. In primary syphilis both the Wassermann and Noguchi tests showed 100 per cent. of positive reactions. In secondary syphilis the percentages of reactions were, Wassermann 97 per cent., Noguchi 100 per cent., in tertiary syphilis, Wassermann 71 per cent., Noguchi 84 per cent.; in latent syphilis,

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[6] Fox: Jour. Cutan. Dis., 1909, xxvii, 338.

Wassermann 46 per cent., Noguchi 62 per cent.; in hereditary syphilis, Wassermann 100 per cent., Noguchi 100 per cent., (only one case reported); in tabes Wassermann 100 per cent., Noguchi 100 per cent., (three cases reported); cases for diagnosis, Wassermann 39 per cent., Noguchi 49 per cent., (53 cases reported.) Of non-syphilitic cases, 2 cases out of 23 gave a positive reaction by Wassermann while 4 gave a positive reaction by the Noguchi test. One of these cases was afterward examined by Noguchi and gave a negative reaction.

In a similar series of cases reported by Kaplan,[7] out of 1,286 cases examined the positive reactions by the Wassermann test were 826 and by the Noguchi test 995.

Swift[8] in a carefully prepared article on "A Comparative Study of Serum Diagnosis in Syphilis," accompanied by numerous tables showing the number and kind of cases in which the serum diagnosis was tried, concludes that the Noguchi reaction is more readily applied and the materials are more easily procured and kept than with the Wassermann method. It is also more sensitive than the Wassermann reaction, though this increased sensitiveness sometimes causes a positive reaction with non-specific serums which gave a negative Wassermann reaction. Noguchi, however, states that these positive reactions with non-specific serum may be avoided by the use of inactive serum, and further that when one obtains a high percentage of positive reactions in non-syphilitic cases one should suspect that one is not doing the test properly.

Numerous investigators have attempted to determine the result of various forms of treatment on the syphilitic antibodies in the blood. It is known that the reaction frequently disappears after a short course of treatment, often to return again within a greater or lesser period of time. In some cases a positive reaction frequently persists in spite of treatment, and Noguchi states that in hereditary lues the reaction is difficult to get rid of, often persisting in spite of most vigorous interference. Frequent tests are necessary to determine whether further therapeusis is indicated. A positive reaction in a syphilitic case is an indication for additional treatment though it is not definitely established that the disappearance of the reaction is justification for the cessation of treatment.

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[7] Kaplan: Comparison of Noguchi and Wassermann Reactions, Table taken from Noguchi's Serum Diagnosis of Syphilis, 1910.

[8] Swift, H. F.: A Comparative Study of Serum Diagnosis in Syphilis, Arch. Int. Med., October, 1909, iv, 376.

It having been definitely established that by the serum test we are able to diagnose syphilis with more or less certainty, it is clearly evident that the test is going to prove of inestimable value to the ophthalmologist who constantly sees many cases of doubtful syphilitic origin. The method is used not only for the diagnosis of syphilis primarily but also as a guide to determine when treatment may be discontinued, or whether it should be resumed.

Up to the present time the reports do not show many eye cases in which the test has been used, though it is possible that some of the statistics in which the cases are grouped under the various types of syphilis may include some eye lesions. Noguchi reports only 29 cases of eye diseases in which his test was employed, and his table is here reproduced:

TABLE 2.—CASES OF EYE DISEASES TESTED BY NOGUCHI BY HIS METHOD

	Cases Examined	+	—	±
Keratitis interstitialis	12	8	4	0
Iritis	6	4	2	0
Scleritis	1	0	1	0
Paralysis external rectus	1	0	1	0
Optic neuritis	1	1	0	0
Chorioiditis (exudative)	1	0	1	0
Optic atrophy	5	0	5	0
Acromegaly with ocular symptoms	2	1	1	0
Totals	29	14	15	0

In this series of cases it will be seen that nearly 50 per cent. of positive reactions were obtained. No reference is made to syphilitic history or the possible effect of treatment in causing a negative reaction in a case of syphilitic origin. Thus out of twelve cases of interstitial keratitis, which in a very large percentage of instances is of syphilitic origin, but eight positive reactions were secured. It would be interesting to know whether any of these negative reactions occurred in patients reasonably free from the possibility of syphilitic infection or whether treatment had anything to do with the results secured from the test.

From Dr. Swift's tables I have been able to select ten cases of eye diseases in which the data is more complete. They may be arranged as in Table 3.

TABLE 3.—SWIFT'S CASES OF EYE DISEASES TESTED BY THE WASSERMANN AND NOGUCHI REACTIONS

Time Since Appearance of First Symptoms	Present Manifestations	Treatment	Wassermann	Noguchi
Four months.	Maculopapular; iritis.	6 weeks bichlorid pills.	+	+
Three months.	Papular; iritis.	Eighteen inunctions.	++	++
Five months.	Iritis.	Four months.	+	+
Two years.	Conjunctivitis.	Fair.	+	++
Six months.	Papular; iritis.	Poorly.	—	++
Three years.	Iritis.	None.	++	+
Denied.	Keratitis, myositis.	None.	+	+
Denied.	Optic atrophy; blindness.	Not stated.	+—	+
Indefinite.	Ocular palsy; blindness.	Much in past two years.	—	—
Denied.	Syphilitic iritis.	Little.	++	++

An analysis of these cases shows only one negative reaction by the Noguchi test, which was also negative with the Wasserman test, and this case was one of ocular palsy accompanied by blindness, of questionable syphilitic history though the patient had had much antisyphilitic treatment for two years previous to the test. It is probable that the negative reaction in this case was due to the treatment, and that earlier in the history of the case the reaction would have been positive. In one case of iritis, with papular eruption, the initial lesion having been six months before the test, the Wassermann reaction was negative and the Noguchi reaction was decidedly positive. In the case of optic atrophy and blindness, in which syphilitic infection was denied, the Wassermann reaction was questionable, and the Noguchi reaction was weakly positive. Of particular interest are the four cases in which the history of infection is indefinite or infection is positively denied, and the lesion is doubtfully syphilitic from clinical symptoms and manifestations. In three of these cases the Noguchi reaction is positive and in the one that is negative the patient had much treatment for two years preceding the test. In all of the other cases there was a history of infection leading to the supposition that unless the patient had had much treatment the Noguchi reaction would be positive.

With a view to determining the clinical value of the serum test for syphilis in eye diseases and especially those of doubtful etiology I took up the work several months ago and in carrying it on I have had the cooperation of my assistant, Dr. Norma B. Elles, and of Dr. C. G. Beall, to whom I am indebted for valuable assistance. Owing to the difficulties encountered in satisfactorily carrying out the test and eliminating the commoner errors in technic bound to occur at first, it was only recently that our results have been considered in any sense reliable. It is frankly admitted that the absolute accuracy of the reported findings may be questioned on the ground that errors in technic are more likely to occur with those who are not specially skilled in hemolytic work, and who have not had the advantage of a long and varied experience. But in view of the scarcity of literature concerning the value of the tests in eye diseases I have thought our results in a limited number of cases worthy of report, though it is hoped that a subsequent report covering a very much larger number of

TABLE 4.—AUTHOR'S CASES TESTED BY THE NOGUCHI METHOD

No.	Sex	Age	History of Infection	Manifestations	Treatment Before Test	Noguchi Reaction
1	F	34	Indefinite	Ectopia lentis. Opacities cornea due to old interstitial keratitis.	Some treatment for congenital syphilis.	—
2	F	14	Congenital	Interstitial keratitis. Numerous scars at corner of mouth and on face. Saddle-nose.	Much treatment for inherited syphilis.	—
3	F	20	Congenital	Old adhesions of the iris. Blepharitis. Interstitial keratitis.	Now taking antisyphilitic treatment. (Mercury.)	+
4	F	17	Congenital	Hutchinson teeth and other signs of congenital syphilis. Opacities of cornea. No active lesions.	Much antisyphilitic treatment.	—
5	M	13	Congenital	Granular conjunctivitis. Ulcer of the cornea.	Unknown.	—
6	F	21	Indefinite	Argyle-Robertson pupil and optic atrophy.	None.	+++
7	M	15	Indefinite	Scars of cornea. Adhesions iris. Nystagmus.	Questionable antisyphilitic treatment.	—
8	M	15	Questionable	Scars on cornea. Active phlyctenular conjunctivitis et iritis.	None.	++
9	F	14	Congenital	Saddle-nose. Scars corner of mouth. Interstitial keratitis 1 year ago.	Mercurials for several weeks 1 year ago.	++
10	F	26	Questionable	Neuroretinitis.	None.	++
11	M	40	Indefinite	Paralysis sixth nerve.	None (after a month's mercurial inunctions Noguchi reaction + ; after two months' treatment still +).	+++
12	F	29	Denied	Maculopapular eruption; ulceration of pharynx and nose, and iritis two years ago. Old adhesions iris. Active corneal ulcerations.	Two years of active mercurial treatment (inunctions).	—
13	M	18	None	Hemorrhage into vitreous left eye. Obliterating endarteritis right eye with hemorrhages and dust-like opacities in vitreous.	None (after a month's mercurial treatment and pilocarpin sweats Noguchi reaction +).	++

14	M	8	None	Interstitial keratitis one year ago. Ulceration tonsil and pharynx six months ago, smears from which showed *Spirochæta pallida.*	Mercury inunctions irregularly for one year. (After one month's continuous mercurial inunctions and injections Noguchi reaction +).	+++
15	F	60	None	Third nerve paralysis. Neuroretinitis.	Mixed treatment and pilocarpin sweats for a week.	+
16	M	38	None	Central leucoma. Active iritis.	None.	—
17	M	25	None	Iridocyclitis.	None.	—
18	F	24	None	Old adhesions and exudate closing pupil left eye. Active iritis right eye.	None.	—
19	F	64	None	Neuroretinitis and floating opacities in vitreous both eyes.	None.	—
20	M	31	None	Repeated hemorrhages in vitreous left eye for three years. Slight hemorrhages vitreous right eye. Obliterating endarteritis and hemorrhages in retina right eye.	K. I. irregularly for several months. Mercury for past few days.	+
21	F	35	Indefinite	Two attacks iritis in last six years. Mild attack iritis within last two weeks. History of two miscarriages.	Unknown.	+
22	F	47	None	Active episcleritis.	None.	—
23	F	31	Denied	Active ulceration nasal septum and iritis eight years ago. Return of ulceration two years ago. Iritis and interstitial keratitis now.	Active mercurial treatment for three years. Six months of mixed treatment two years ago.	+++
24	M	54	None	Repeated subconjunctival hemorrhages both eyes for past three years.	Unknown. Probably antisyphilitic from description.	+
25	F	52	Indefinite	Aphasia and one-sided sensory paralysis and partial motor paralysis. Few small spots of disseminated chorioiditis. History of one miscarriage.	Inunctions and large doses K. I. for six weeks. (Has recovered from aphasia and paralysis.)	—
26	F	50	Negative	Large syphilitic ulcer left tonsil, smears from which showed *Spirochæta pallida* nine months ago. Old disseminated chorioiditis right eye.	Almost continuous inunctions for eight months.	—

cases, and reviewing the results secured by others, will throw still further light on what, it seems, must eventually be one of the most important diagnostic means at the hands of the ophthalmologist for diagnosing eye lesions of questionable syphilitic etiology.

In all of the tests, only a portion of which are reported, fresh guinea-pig serum was used as complement. The amboceptor, consisting of the serum from immunized rabbits, was obtained from the laboratory of the Memorial Institute for Infectious Diseases, Chicago, though in some of the tests amboceptor slips which originally came from Dr. Noguchi, of the Rockefeller Institute, were used. Our antigen, made from the alcoholic extract of the liver of a congenitally syphilitic fetus, was also obtained in the form of antigen slips which had been carefully standardized.

Unfortunately the first tests, consisting of a number of cases, proved worthless owing to a poor quality of antigen, as well as one which had not been carefully prepared and standardized. In consequence some of these cases were either lost sight of when we finally got the tests working satisfactorily, or treatment modified the result. The ear, nose and throat cases, which were also studied in connection with the eye cases, are not considered in this paper.

The cases, with condensed history and results of test recorded, are given in Table 4.

An analysis of these cases shows that of the thirteen positive reactions ten were in patients giving no definite history of syphilitic infection, and only two of the eight showed other than eye lesions to indicate syphilitic infection. Seven of the number had received antisyphilitic treatment and probably to the treatment may be attributed some of the weak positive reactions secured.

Of the thirteen negative reactions six were in patients who gave no history of syphilitic infection and received no antisyphilitic treatment. One patient (Case 12) denied infection but presented many evidences of secondary manifestations of the disease and was kept on mercurial inunctions for a period of two years previous to the test and constantly improved under the treatment. She gave a negative Noguchi reaction and no doubt the vigorous mercurial treatment and absence of active syphilitic lesions prevented a positive reaction. The same is true of Patient 26.

The four patients giving a history of syphilitic infection and treatment of the same probably gave negative Noguchi reactions because of the effect of the treatment. The lesions existing at the time of the tests were probably not syphilitic.

The patients suffering from or having suffered from interstitial keratitis would be expected to be syphilitic, and hence the Noguchi reaction in such cases would be positive except for the inhibiting influence of the treatment. The test in those cases, therefore, would be essentially valuable as indicating whether or not treatment should be discontinued or resumed.

In the cases of iritis, except Case 23 (neuroretinitis, hemorrhages into the vitreous, and paralysis of eye muscles) there was no obtainable syphilitic history, no lesions other than those in the eye, and the cause was questionable. The serum reaction was considered satisfactory in determining the possibility of syphilitic etiology, and the results of subsequent treatment seem to establish the reliability of the findings. Thus in Case 11 the test was strongly positive and active antisyphilitic treatment not only produced marked improvement in the eye lesion but probably was responsible for a weakly positive reaction six weeks later. In Case 12, with unquestioned syphilitic lesions, and under active mercurial treatment for two years, the reaction was negative. This is considered an indication for cessation of treatment. Tests will be given later to determine whether treatment should be resumed. The active corneal ulcerations are considered as due to the effects of cicatricial changes in the lids, producing mechanical irritation, and the introduction of non-syphilitic infection. Case 14, with no active lesion, is considered as requiring more antisyphilitic treatment owing to the positive Noguchi reaction. Case 18 is one that ordinarily would be diagnosed as syphilitic iritis, but the Noguchi reaction was negative and the patient promptly recovered on treatment other than antisyphilitic.

Various writers have asserted that the reaction frequently disappears after a short course of treatment, often to return again within a greater or lesser period of time. This would seem to be borne out by the results secured in the cases reported by Noguchi, Brück, Citron, Swift and others. In our cases treatment very evidently tended to cause a disappearance of the reaction, and those patients who had received considerable antisyphilitic treatment and exhibited no active lesions at the time of the test, showed a negative reaction. Positive reactions were reduced to weakly positive following active mercurial treatment. Whether a positive reaction will be obtained in these cases later, after an interval of rest in treatment, will be determined later. Noguchi says that in hereditary lues the reaction is difficult to get rid of, often persisting in spite of the most vigorous interference. In several of our cases of congenittal syphilis we secured a negative reaction which was thought to be due to the inhibitory action of treatment. Noguchi also says that the reaction may return shortly after cessation of treatment, so that it may be necessary to make frequent tests to determine whether further therapeusis is indicated. On the other hand he admits that it is not definitely established that the disappearance of the reaction is justification for the cessation of treatment, especially as the reaction may be quickly affected by treatment.

In conclusion it may be said that the reaction is destined to be of value to the ophthalmologist as an aid in making a diagnosis, particularly in cases of doubtful origin, and also as a guide to selection of therapeutic measures. But to be reliable and hence of most value the test should be applied to those cases of which a reasonable complete history has been obtained; the reagents employed should be prepared in an accurate and careful manner; the technic as advocated by Noguchi and others should be accurately followed; and the interpretation of the results considered in the light of the experience and skill with which the tests have been made. The reactions should be verified, and control tests should be introduced as often as possible. Furthermore, all things being equal, the results will be most reliable and hence most valuable when done by those who have the facilities and training for hemolytic work.

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